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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT
ADDENDUM CORRECTIVE MEASURES STUDY WORK PLAN AREA OF CONCERN 563
(AOC 563) ZONE E CNC CHARLESTON SC
10/28/2002
CH2M HILL

RFI REPORT ADDENDUM

RFI Report Addendum and CMS Work Plan AOC 563 Zone E



***Charleston Naval Complex
North Charleston, South Carolina***

SUBMITTED TO
***U.S. Navy Southern Division
Naval Facilities Engineering Command***

CH2M-Jones

October 2002

Contract N62467-99-C-0960



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October 28, 2002

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Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Re: RFI Report Addendum and CMS Work Plan (Revision 0) – AOC 563, Zone E

Dear Mr. Scaturo:

Enclosed please find four copies of the RFI Report Addendum and CMS Work Plan (Revision 0) for AOC 563 in Zone E of the Charleston Naval Complex (CNC). This report has been prepared pursuant to agreements by the CNC BRAC Cleanup Team for completing the RCRA Corrective Action process.

The principal author of this document is Sam Naik. Please contact him at 770/604-9182, extension 255, if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

cc: Rob Harrell/Navy, w/att
Gary Foster/CH2M HILL, w/att

RFI REPORT ADDENDUM

RFI Report Addendum and CMS Work Plan AOC 563, Zone E



***Charleston Naval Complex
North Charleston, South Carolina***

SUBMITTED TO
***U.S. Navy Southern Division
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PREPARED BY
CH2M-Jones

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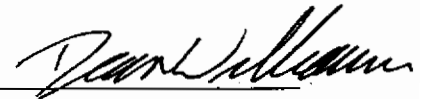
*Revision 0
Contract N62467-99-C-0960
158814.ZE.PR.07*

**Certification Page for RFI Report Addendum and CMS Work
Plan (Revision 0) – AOC 563, Zone E**

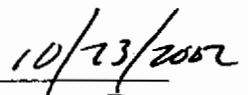
I, Dean Williamson, certify that this report has been prepared under my direct supervision.
The data and information are, to the best of my knowledge, accurate and correct, and the
report has been prepared in accordance with current standards of practice for engineering.

South Carolina

P.E. No. 21428



Dean Williamson, P.E.



Date

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- 2 **B** CH2M-Jones' Responses to SCDHEC Comments for AOC 563 from the *Zone E RFI*
- 3 *Report, Revision 0* (EnSafe, 1997)
- 4 **C** Excerpts from the *Zone E RFI Report, Revision 0* (EnSafe, 1997), including Figure C-1,
- 5 *Shallow Groundwater Contour Map*
- 6 **D** Zone E Groundwater Sampling Form

1 Acronyms and Abbreviations

| | | |
|----|---------|--------------------------------------|
| 2 | AOC | Area of concern |
| 3 | AST | Aboveground storage tank |
| 4 | BCT | BRAC Cleanup Team |
| 5 | BEQ | Benzo[a]pyrene equivalent |
| 6 | BRAC | Base Realignment and Closure Act |
| 7 | BRC | Background reference concentration |
| 8 | CA | Corrective action |
| 9 | CMS | Corrective measures study |
| 10 | CNC | Charleston Naval Complex |
| 11 | COC | Chemical of concern |
| 12 | COPC | Chemical of potential concern |
| 13 | CSI | Confirmatory Sampling Investigation |
| 14 | DAF | Dilution attenuation factor |
| 15 | DET | Environmental Detachment Charleston |
| 16 | EnSafe | EnSafe Inc. |
| 17 | EPA | U.S. Environmental Protection Agency |
| 18 | FRE | Fixed-point risk evaluation |
| 19 | HHRA | Human Health Risk Assessment |
| 20 | HI | Hazard index |
| 21 | ILCR | Incremental lifetime cancer risk |
| 22 | IM | Interim measure |
| 23 | LUC | Land use control |
| 24 | MCL | Maximum contaminant level |
| 25 | MCS | Media cleanup standard |
| 26 | µg/kg | Micrograms per kilogram |
| 27 | µg/L | Micrograms per liter |
| 28 | mg/kg | Milligrams per kilogram |
| 29 | mg/L | Milligrams per liter |
| 30 | NAVBASE | Naval Base |

1 **Acronyms and Abbreviations, Continued**

| | | |
|----|--------|---|
| 2 | NFA | No further action |
| 3 | NFI | No further investigation |
| 4 | OP | Organophosphorous |
| 5 | OWS | Oil/water separator |
| 6 | PCB | Polychlorinated biphenyl |
| 7 | POL | Petroleum, oil, and lubricant |
| 8 | RAO | Remedial action objective |
| 9 | RBC | Risk-based concentration |
| 10 | RCRA | Resource Conservation and Recovery Act |
| 11 | RFI | RCRA Facility Investigation |
| 12 | RGO | Remedial goal option |
| 13 | RI | Remedial investigation |
| 14 | SAP | Sampling and Analysis Plan |
| 15 | SCDHEC | South Carolina Department of Health and Environmental Control |
| 16 | SSL | Soil screening level |
| 17 | SVOC | Semivolatile organic compound |
| 18 | SWMU | Solid waste management unit |
| 19 | TDS | Total dissolved solids |
| 20 | VOC | Volatile organic compound |
| 21 | UST | Underground storage tank |

Section 1.0

1.0 Introduction

In 1993, Naval Base (NAVBASE) Charleston was added to the list of bases scheduled for closure as part of the Defense Base Realignment and Closure Act (BRAC), which regulates closure and transition of property to the community. The Charleston Naval Complex (CNC) was formed as a result of the dis-establishment of the Charleston Naval Shipyard and NAVBASE on April 1, 1996.

Corrective Action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA), with the South Carolina Department of Health and Environmental Control (SCDHEC) as the lead agency for CA activities at the CNC. All RCRA CA activities are performed in accordance with the Final Permit (Permit No. SC0 170 022 560).

In April 2000, CH2M-Jones was awarded a contract to provide environmental investigation and remediation services at the CNC. This submittal has been prepared by CH2M-Jones to complete the RCRA Facility Investigation (RFI) for Area of Concern (AOC) 563 in Zone E of CNC. The location of this site in Zone E is shown in Figure 1-1. Figure 1-2 shows an aerial photograph of the site.

1.1 Background

AOC 563 is former Building 37, a locomotive maintenance house constructed in 1913 that was used until 1939. According to the *Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) Report* (EnSafe Inc.[EnSafe]/Allen & Hoshall, 1995a), probable maintenance activities at Building 37 involved petroleum-based lubricants, chlorinated solvents and degreasers, and coal or petroleum fuels. Building 177 was built over the site of former Building 37 in 1955. Building 177 is currently being used for storage and equipment maintenance activities in support of the operations by Detyens Shipyards, Inc.

The materials of concern identified in the *Final Zone E RFI Work Plan, Revision 1* (EnSafe/Allen & Hoshall, 1995b) include lubricants, heavy metals, dielectric fluid, petroleum hydrocarbons, chlorinated solvents and degreasers, and coal/coal by-products. This area of Zone E is zoned M-2, for industrial usage. The CNC RCRA Permit identified AOC 563 as requiring a Confirmatory Sampling Investigation (CSI). A focused Corrective Measures Study (CMS) Work Plan is also provided in this submittal, in order to address potential remedies for chemicals of concern (COCs) identified at AOC 563.

A review of the historical engineering drawings for this site shows that railroad lines were previously located directly adjacent to the southwest and northeast sides of former Building 37. It is likely that railroad lines extended into former Building 37, as shown in Figure A-1 of Appendix A of this report. The railroad lines were either paved over or removed sometime after 1940.

The RFI was initially conducted by the Navy/EnSafe team. The RFI activities are described in the *Zone E RFI Report, Revision 0* (EnSafe, 1997). Regulatory review was conducted on this document and draft responses to the comments from SCDHEC on this document were prepared by the Navy/EnSafe team. A copy of the responses to these comments is provided in Appendix B of this document.

1.2 Purpose of the RFI Report Addendum

The purpose of this RFI Report Addendum is to document the results of previous RFI investigations conducted by EnSafe at AOC 563. This RFI Report Addendum also discusses various closeout issues and the findings of previous investigations, existing site conditions, and surrounding area land use.

Prior to changing the status of any site in the CNC RCRA CA permit, the BRAC Cleanup Team (BCT) agreed that the following issues should be considered:

- Status of the RFI
- Presence of metals (inorganics) in groundwater
- Potential linkage to SWMU 37, Investigated Sanitary Sewers at the CNC
- Potential linkage to Area of Concern (AOC) 699, Investigated Storm Sewers at the CNC
- Potential linkage of AOC 504, Investigated Railroad Lines at the CNC
- Potential linkage to surface water bodies (Zone J)
- Potential contamination associated with oil/water separators (OWSs)
- Relevance or need for land use controls (LUCs) at the site

Information regarding these issues is also provided in this RFI Report Addendum to expedite evaluation of closure of the site.

1.3 Report Organization

This RFI Report Addendum consists of the following sections, including this introductory section:

1.0 Introduction – Presents the purpose of the report and background information relating to the RFI Report Addendum.

2.0 Summary of RFI Conclusions for AOC 563 – Summarizes the conclusions from the RFI investigations and risk evaluations for AOC 563 as presented in *the Zone E RFI Report, Revision 0* (EnSafe, 1997).

3.0 Interim Measures and UST/AST Removals – Provides information regarding any interim measures (IMs) or tank removal activities performed at the site.

4.0 Summary of Additional Investigations – Summarizes information, if any, collected after completion of the *Zone E RFI Report, Revision 0*.

5.0 COPC/COC Refinement – Provides further evaluation of chemicals of potential concern (COPCs) based on RFI and additional data to assess them as COCs.

6.0 Summary of Information Related to Site Closeout Issues – Discusses the various site closeout issues that the BCT agreed to evaluate prior to site closeout.

7.0 Recommendations – Provides recommendations for proceeding with a CMS for AOC 563.

8.0 CMS Work Plan – Presents a focused CMS Work Plan for AOC 563.

9.0 References – Lists the references used in this document.

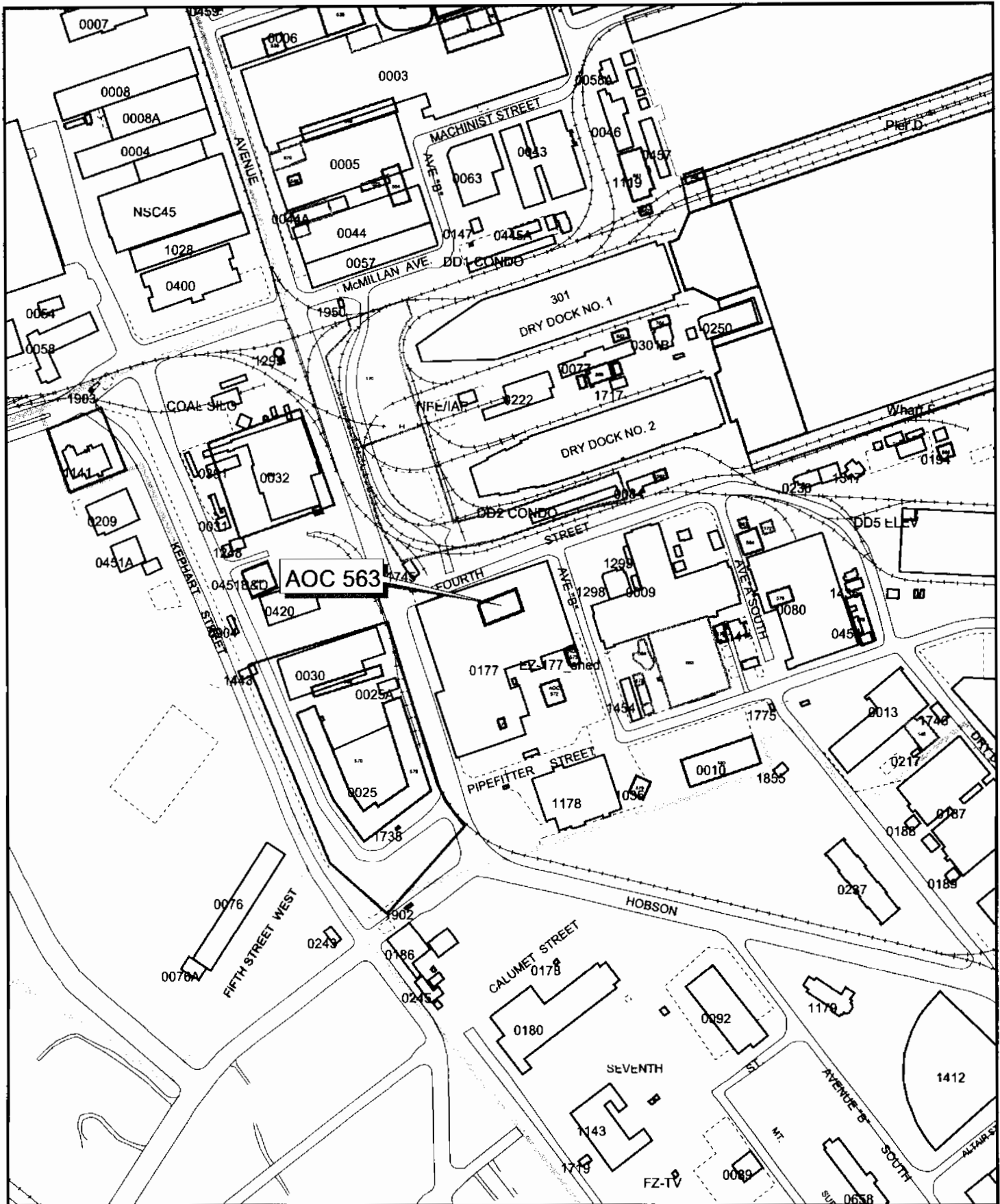
Appendix A– Contains Figure A-1, which presents the site location from the Public Works Map of the Charleston Naval Shipyard dated December 15, 1939, and depicts the presence of railroad lines at the site.

Appendix B – Contains responses to SCDHEC comments for AOC 563 from the *Zone E RFI Report, Revision 0* (EnSafe, 1997).

Appendix C – Contains excerpts from the *Zone E RFI Report, Revision 0*, including summaries of detections of chemicals and a groundwater flow map for the site vicinity.

Appendix D contains a copy of the relevant groundwater sampling form for Zone E at the CNC.

All tables and figures appear at the end of their respective sections.



- Fence
- Railroads
- Roads
- Shoreline
- AOC Boundary
- SWMU Boundary
- Buildings
- Zone Boundary

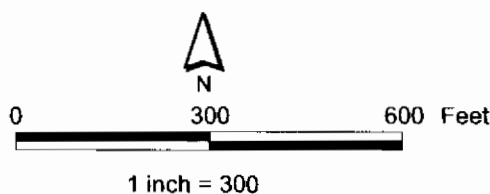


Figure 1-1
Location of AOC 563 in Zone E
AOC 563, Zone E
Charleston Naval Complex

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- Fence
- Railroads
- Roads
- AOC Boundary
- SWMU Boundary
- Buildings

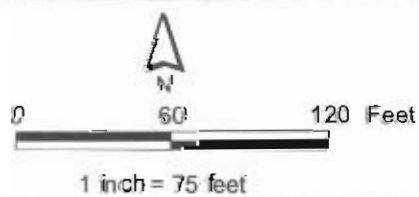


Figure 1-2
Aerial Photograph of AOC 563
AOC 563, Zone E
Charleston Naval Complex

2.0 Summary of RFI Conclusions for AOC 563

This section summarizes the results and conclusions from the soil and groundwater investigations conducted at AOC 563 as reported in the *Zone E RFI Report, Revision 0* (EnSafe, 1997). Appendix C contains excerpts from the RFI report, including a summary of detections of chemicals and a groundwater flow map for the site vicinity.

As part of the Zone E RFI, soil and groundwater investigations were conducted at AOC 563 during 1996-1998. The RFI report presented the results of these investigations and conclusions concerning contamination and risk, as summarized in the following sections. A further evaluation of the COCs identified at this site is provided in Section 5.0. Figure 2-1 shows the soil and groundwater sampling locations.

2.1 Soil Sampling and Analysis

The RFI at AOC 563 included the collection and analysis of six surface soil and six subsurface soil samples from locations under concrete and asphalt pavement during a single sampling event. Surface soil and subsurface soil samples were also collected during the installation of the three shallow monitoring wells at the site. All samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, pesticides/polychlorinated biphenyls (PCBs), and cyanide. The soil boring locations were identified as E563SB001 through E563SB009. Two soil samples (one surface and one subsurface) were selected as duplicates and were also analyzed for herbicides, organophosphorus (OP) pesticides, hexavalent chromium, and dioxins.

2.1.1 Surface Soil Results

During the RFI, surface soil detections of organic compounds were evaluated against the U.S. Environmental Protection Agency (EPA) Region III industrial risk-based concentrations (RBCs) (adjusted to a hazard index [HI]=0.1 for noncarcinogens). The surface soil detections of inorganic compounds were evaluated against the EPA Region III industrial RBCs (HI=0.1 for noncarcinogens) and the Zone E background reference concentrations (BRCs).

Detected concentrations of organic and inorganic analytes exceeding their respective criteria are as follows:

VOCs: No VOC detections exceeded the screening criteria in surface soil.

2.2.1 Shallow Groundwater Results

Analyte concentrations in shallow groundwater samples were detected as follows at this site:

VOCs: The RFI report identified detections in the first sampling event only. Among the detected VOC analytes, only trichloroethene (TCE), at a concentration of 120 micrograms per liter ($\mu\text{g/L}$), exceeded both its secondary MCL of $5.00 \mu\text{g/L}$ and the tap water RBC of $1.60 \mu\text{g/L}$ (HI=0.1).

SVOCs: No SVOC detections exceeded the screening criteria in shallow groundwater samples from AOC 563.

Inorganics: The *Zone E RFI Report, Revision 0* reported detections in the first sampling event only. Among detected inorganic analytes, the RFI identified six metals as exceeding at least one of the RFI screening criteria:

- Aluminum – one sample (E563GW00101) exceeded both the tap water RBC and shallow groundwater BRC for aluminum at a concentration of $22,000 \mu\text{g/L}$. No shallow groundwater MCL was developed for aluminum in Zone E during the RFI.
- Arsenic – two samples (E563GW00101 and E563GW00201) exceeded both the tap water RBC and shallow groundwater BRC for arsenic at concentrations of $34.4 \mu\text{g/L}$ and $26.7 \mu\text{g/L}$, respectively. Neither detection exceeded the arsenic MCL of $50 \mu\text{g/L}$.
- Chromium - one sample (E563GW00101) exceeded both the tap water RBC and shallow groundwater BRC for chromium at a concentration of $42.9 \mu\text{g/L}$. The detection did not exceed the chromium MCL of $100 \mu\text{g/L}$.
- Iron - two samples (E563GW00101 And E563GW00201) exceeded both the tap water RBC and shallow groundwater BRC for iron at concentrations of $29,000 \mu\text{g/L}$ and $6,160 \mu\text{g/L}$, respectively. No shallow groundwater BRC or MCL was developed for iron in Zone E during the RFI.
- Lead - one sample (E563GW00101) with a concentration of $17.6 \mu\text{g/L}$ exceeded both the treatment technique action level (TTAL) for lead of $15 \mu\text{g/L}$ and the Zone E shallow groundwater BRC of 4.8 milligrams per liter (mg/L).

Pesticides/PCBs: There were no detections of pesticides/PCBs above laboratory detection limits in shallow groundwater samples from AOC 563.

2.2.2 Deep Groundwater Results

Detections in the deep groundwater samples at the site were as follows:

VOCs: There were no VOC detections above laboratory detection limits in deep groundwater samples from AOC 563.

SVOCs: There were no SVOC detections above laboratory detection limits in deep groundwater samples from AOC 563.

Inorganics: None of the detected metals exceeded their respective tap water RBCs, MCLs, or deep groundwater BRCs.

Pesticides/PCBs: There were no detections of pesticides/PCBs above laboratory detection limits in deep groundwater samples from AOC 563.

2.3 RFI Human Health Risk Assessment (HHRA)

The RFI report used a fixed-point risk evaluation (FRE) approach at this site. The FRE considered site resident and site worker scenarios. The detailed risk assessment for the AOC 563 site are presented in Sections 10.31.6.2 and 10.31.6.3 of the *Zone E RFI Report, Revision 0* (EnSafe, 1997).

2.3.1 Soils

For the unrestricted (i.e., residential) future land use scenario, BEQs were retained as COCs for surface soil. No COCs were identified in subsurface soil at AOC 563, and no COCs were identified in soil during the RFI under the industrial reuse scenario.

2.3.2 Groundwater

Aluminum, arsenic, lead, and TCE were retained as shallow groundwater COCs. The FRE did not identify any COCs in deep groundwater monitoring wells at AOC 563.

2.4 RFI Conclusions and Recommendations

The *Zone E RFI Report, Revision 0* recommended that a CMS be conducted for 1) BEQs in surface soil, and 2) aluminium, arsenic, lead, and TCE in shallow groundwater at AOC 563.

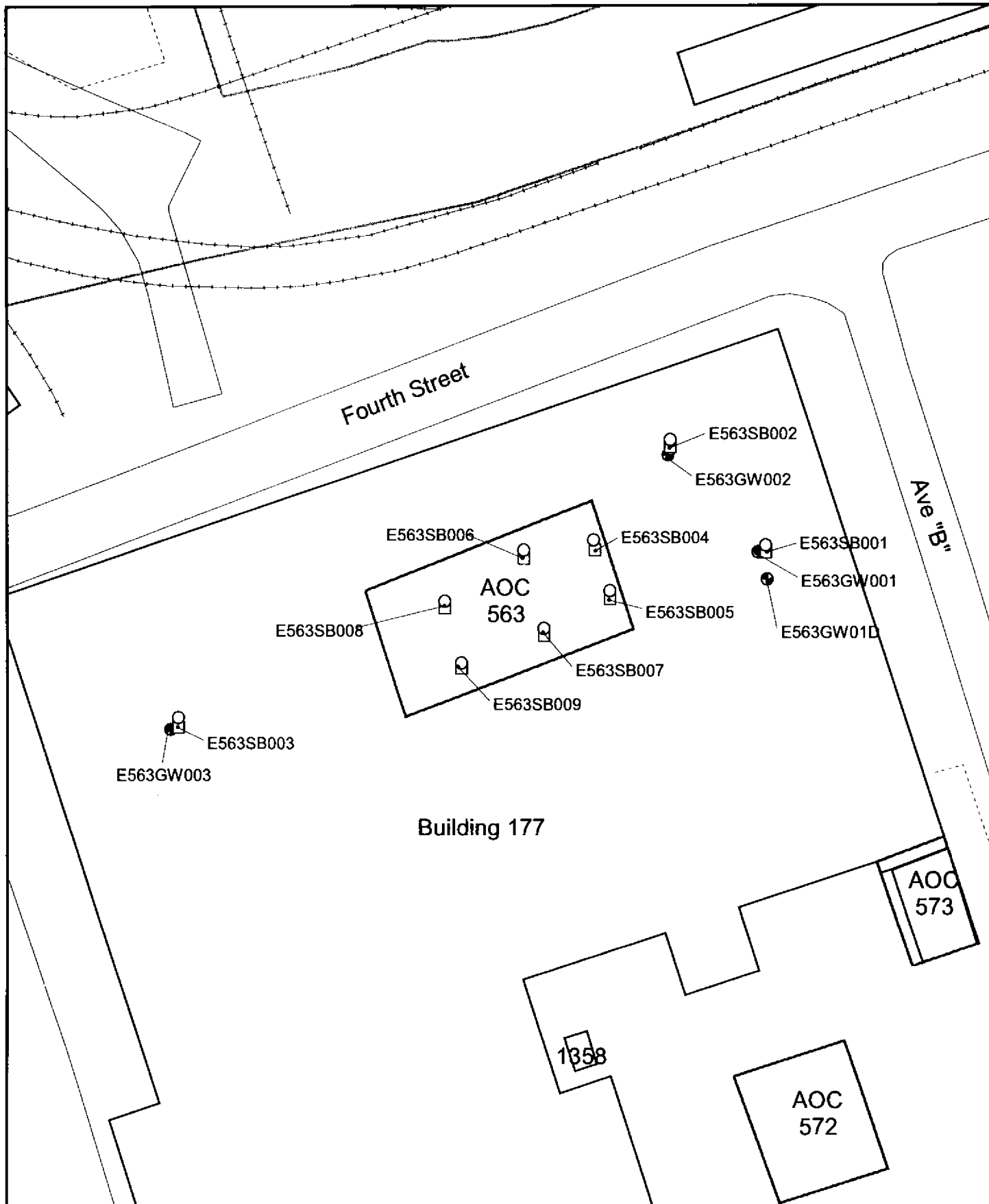


Figure 2-1
RFI Sampling Locations
AOC 563, Zone E
Charleston Naval Complex

1 **3.0 Interim Measures and UST/AST Removals**

2 **3.1 UST/AST Removals**

3 There is no indication of any underground storage tank (UST) being present at this site. An
4 aboveground storage tank (AST) that was used to store kerosene is located outside at the
5 southwest corner of Building 177, which is outside the boundary of AOC 563. A review of
6 available maps and documents by CH2M-Jones did not reveal the presence of a UST.

7 **3.2 Interim Measures**

8 There were no IMs conducted at the site.

1 **4.0 Summary of Additional Investigations**

- 2 No additional investigations have been conducted at AOC 563 since the RFI field
3 investigations conducted by the Navy/EnSafe team during the period of 1996-1998.

1 5.0 COPC/COC Refinement

2 The *Zone E RFI Report, Revision 0* (EnSafe, 1997) identified BEQs as surface soil COCs and
3 aluminum, arsenic, lead, and TCE as shallow groundwater COCs for AOC 563. These
4 chemicals are discussed further in the following sections.

5 In addition, the BCT has agreed that detections of VOCs in surface and subsurface soil
6 should be rescreened using generic SSLs that are based on DAF=1. This section presents the
7 results of this additional screening.

8 5.1 COCs in Surface Soil

9 5.1.1 BEQs

10 The RFI reported that among detected SVOC compounds, BEQ concentrations (which
11 ranged from 0.501 to 137.8 micrograms per kilogram [$\mu\text{g}/\text{kg}$]) did not exceed the industrial
12 land use RBC of 780 $\mu\text{g}/\text{kg}$ for benzo[a]pyrene. However, BEQs were identified in the RFI
13 report as a COPC based on exceedances of the residential RBC of 88 $\mu\text{g}/\text{kg}$ for
14 benzo[a]pyrene. Based on the BEQ calculation method currently adopted by the CNC BCT,
15 the BEQ concentrations in the soil samples range from 287 to 474 $\mu\text{g}/\text{kg}$ and do not exceed
16 the CNC BEQ site-wide reference concentration of 1,304 $\mu\text{g}/\text{kg}$, as shown in Table 5-1. For
17 these reasons, BEQs are not considered COCs for surface soil at this site.

18 5.1.2 Soil VOC Screening using SSL at DAF=1

19 Soil VOC detections were compared to SSLs at DAF =1. Acetone, methylene chloride, and
20 TCE were detected in soil samples at AOC 563. Only one chemical, methylene chloride,
21 exceeded this screening criteria. Methylene chloride was detected in three of nine surface
22 soil samples and five of nine subsurface soil samples. The detections of methylene chloride
23 above the SSL (DAF=1) ranged from 13 to 16 $\mu\text{g}/\text{kg}$ in three surface soil samples, and from
24 7 to 25 $\mu\text{g}/\text{kg}$ in five subsurface soil samples, as shown in Tables 5-2 and 5-3. All of these
25 detections exceeded the SSL of 1 $\mu\text{g}/\text{kg}$ (DAF=1).

26 Because methylene chloride concentrations in several soil samples exceeded the generic
27 SSL, a site-specific SSL was calculated for both the unpaved and paved scenarios. The
28 reported concentrations of methylene chloride were compared to the site-specific SSLs. The
29 SSL calculation is consistent with the *EPA Soil Screening Guidance: Technical Background*
30 *Document* (EPA, 1996a) and the *EPA Soil Screening Guidance: User's Guide* (EPA, 1996b).

Table 5-4 presents the SSL calculations and input parameters. The table shows the calculation of SSLs for both paved and unpaved site conditions. The unpaved and paved SSLs are also shown in Tables 5-2 and 5-3.

A comparison of detected concentrations of methylene chloride to the site-specific SSLs resulted in one of the 16 soil samples exceeding the unpaved SSL. All samples contained methylene chloride at concentrations below the paved SSL.

Because individual exceedances of the SSL do not necessarily represent a threat to local groundwater, the mean methylene chloride concentration was compared to the site-specific SSLs. Table 5-5 presents the reported VOC concentrations and the calculated mean concentrations. The detected concentration of each sample was used in the calculation of the mean concentration. For samples where methylene chloride was not detected, one-half of the reported value was used in the calculation.

As can be seen in Table 5-5, the mean concentration of methylene chloride (0.007 mg/kg) is below the paved and unpaved site-specific SSLs. It is not expected to present a threat to the shallow groundwater, even when based on an unpaved scenario. There is currently a building located on this site, and the site is expected to remain paved. Therefore, the migration of methylene chloride is highly unlikely. Based on this information, methylene chloride is not considered a soil COC at AOC 563.

5.2 COCs in Groundwater

5.2.1 Aluminum

The RFI report considered aluminum to be a COC based on the detections of aluminum above the EPA Region III tap water RBC in shallow groundwater at AOC 563. One of these detections during the initial sampling event (E563GW001: 22,000 µg/L) exceeded the maximum Zone E background aluminum concentration in shallow groundwater of 16,100 µg/L. There is no primary MCL for aluminum. The groundwater sampling form for this well for the sampling event where elevated aluminum was detected indicates that the groundwater turbidity was elevated at the time of sampling (367 nephelometric turbidity units [NTUs]). This elevated turbidity is likely the reason for the elevated aluminum in this sample. Appendix D contains a copy of the groundwater sampling form. The aluminum detections in well E563GW001 in the subsequent three groundwater sampling events were below the maximum Zone E background aluminum concentration in shallow groundwater, as shown in Table 5-2. Based on the information presented above, aluminum is not a groundwater COC for this site.

5.2.2 Arsenic

The RFI report considered arsenic to be a COC at AOC 563 based on its detection in two shallow groundwater samples, 563GW00101 and 563GW00201, at concentrations of 34.4 and 26.7 µg/L, respectively, that exceeded both the tap water RBC and shallow groundwater BRC for arsenic. However, neither detection exceeded the state of South Carolina arsenic MCL of 50 µg/L, as shown in Table 5-2. Arsenic detections during the subsequent groundwater sampling events were also below the MCL. For this reason arsenic is not a shallow groundwater COC for this site.

5.2.3 Lead

The RFI report considered lead to be a COC at AOC 563 based on its detection in one shallow groundwater sample during the initial sampling event (E563GW001: 17.6 µg/L) that exceeded both the TTAL of 15 µg/L and shallow groundwater BRC of 4.8 µg/L for lead. Lead detections in well E563GW001 in the subsequent three groundwater sampling events were below the TTAL of 15 µg/L and the maximum Zone E background lead concentration in shallow groundwater of 47µg/L, as shown in Table 5-2. The groundwater sampling form for this well for the sampling event where elevated lead was detected indicates that the groundwater turbidity was also elevated at the time of sampling (367 NTUs). The elevated turbidity is likely the reason for the elevated lead in this sample. See Appendix D for a copy of the groundwater sampling form. Based on the information presented above, lead is not a shallow groundwater COC for AOC 563.

5.2.4 TCE

Table 5-1 and Figure 5-2 show the detected TCE concentrations in shallow groundwater at AOC 563.

As shown in Figure 5-2, the TCE concentrations in the upgradient well E563GW003 appear to be elevated above the MCL, while the TCE concentrations in well E563GW002, which is downgradient of AOC 563, showed only one slight exceedance of the MCL in the third and fourth sampling events (each at 6 µg/L), followed by estimated detections below the MCL in two subsequent sampling events. The TCE concentrations in the upgradient well E563GW003 also showed a steadily decreasing trend over the six sampling events, decreasing from 120 µg/L to a detection below laboratory detection limits in the sixth sampling event in 1998, indicating the possibility of a low-level source in this area that has attenuated naturally over time.

TCE concentrations in the cross-gradient well E563GW001 peaked during the third sampling event in 1996 and showed a decrease to levels below laboratory detection limits in 1998. Based on these trends, TCE may be present at low concentrations from a nearby low-level TCE source but does not appear to be associated with operations at Building 37 (which was demolished prior to the construction of Building 177 in 1955). However, TCE will be retained as a COC in shallow groundwater for this AOC, since AOC 563 is the closest AOC to the detected TCE concentrations in groundwater. TCE will be addressed as part of a focused CMS as outlined in Section 8.0 of this document.

5.3 COC Summary

TCE is identified as a COC in shallow groundwater. TCE contamination in groundwater in the vicinity of AOC 563 will be addressed in a focused CMS, which is provided in Section 8.0 of this report. No other COCs for any media under either the unrestricted or industrial future land use scenarios have been identified at this site.

TABLE 5-1

Detected Concentrations of BEQs in Surface and Subsurface Soil at AOC 563

RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Parameter | Station ID | Sample ID | Concentration (µg/kg) | Qualifier | Date Collected | EPA Region III Residential RBC | SSL (DAF=1) | Zone E Background Range of Conc. |
|-------------------------|------------------------|------------|--------------------------|-----------|-------------------|--------------------------------------|----------------|---|
| BEQs^a | Surface Soil | | | | | 88 | NA | 1,304 |
| | E563SB001 | 563SB00101 | 425 | = | 01/29/1996 | | | |
| | E563SB002 | 563SB00201 | 439 | U | 01/29/1996 | | | |
| | E563SB003 | 563SB00301 | 328 | = | 01/29/1996 | | | |
| | E563SB004 | 563SB00401 | 474 | U | 01/29/1996 | | | |
| | E563SB005 | 563SB00501 | 462 | U | 01/29/1996 | | | |
| | E563SB006 | 563SB00601 | 438 | = | 01/30/1996 | | | |
| | E563SB007 | 563SB00701 | 287 | = | 01/30/1996 | | | |
| | E563SB008 | 563SB00801 | 423 | = | 01/30/1996 | | | |
| | E563SB009 | 563SB00901 | 416 | U | 01/30/1996 | | | |
| | Subsurface Soil | | | | | 88 | NA | 1,400 |
| | E563SB001 | 563SB00102 | 451 | U | 01/29/1996 | | | |
| | E563SB002 | 563SB00202 | 275 | = | 01/29/1996 | | | |
| | E563SB003 | 563SB00302 | 427 | = | 01/29/1996 | | | |
| | E563SB004 | 563SB00402 | 474 | U | 01/29/1996 | | | |
| | E563SB005 | 563SB00502 | 428 | U | 01/29/1996 | | | |
| | E563SB006 | 563SB00602 | 439 | U | 01/30/1996 | | | |
| | E563SB007 | 563SB00702 | 286 | = | 01/30/1996 | | | |
| | E563SB008 | 563SB00802 | 462 | U | 01/30/1996 | | | |
| | E563SB009 | 563SB00902 | 437 | = | 01/30/1996 | | | |

All values are presented in units of micrograms per kilogram (µg/kg).

^a BEQ calculation method based on the background PAHs study report, *Technical Information for Development of Background BEQ Values* (CH2M-Jones, February 2001).

J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.

NA Not applicable/not available.

U Indicates that the concentration was not detected.

TABLE 5-2

Volatile Organic Compounds Detected in Surface Soil at AOC 563

RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Parameter | Station ID | Sample ID | Date Collected | Concentration (mg/kg) | Qualifier | SSL _{generic} (DAF=1) | SSL _{unpaved} (DAF=4.9) | SSL _{paved} (DAF=49) |
|--------------------|------------|------------|----------------|-----------------------|-----------|--------------------------------|----------------------------------|-------------------------------|
| Acetone | E563SB005 | 563SB00501 | 01/29/1996 | 0.072 | J | 0.8 | NA | NA |
| Methylene Chloride | E563SB001 | 563SB00101 | 01/29/1996 | 0.014 | = | 0.001 | 0.016 | 0.156 |
| | E563SB002 | 563SB00201 | 01/29/1996 | 0.016 | = | | | |
| | E563SB003 | 563SB00301 | 01/29/1996 | 0.013 | = | | | |
| TCE | E563SB003 | 563SB00301 | 01/29/1996 | 0.002 | J | 0.015 | NA | NA |

All values are presented in units of milligrams per kilogram (mg/kg).

SSL_{generic} values are from the *EPA Soil Screening Guidance* (EPA, 1996a)

SSL_{unpaved} values are calculated for site- and chemical-specific data (see Table 5-4).

SSL_{paved} values are calculated for site- and chemical-specific data (see Table 5-4).

J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.

= Indicates that the compound was detected, the reported concentration is the measured concentration.

NA Not available/not applicable.

TABLE 5-3

Volatile Organic Compounds Detected in Subsurface Soil at AOC 563

RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Parameter | Station ID | Sample ID | Date Collected | Concentration (mg/kg) | Qualifier | SSL _{generic} (DAF=1) | SSL _{unpaved} (DAF=4.9) | SSL _{paved} (DAF=49) |
|--------------------|------------|------------|----------------|-----------------------|-----------|--------------------------------|----------------------------------|-------------------------------|
| Methylene Chloride | E563SB001 | 563SB00102 | 01/29/1996 | 0.010 | = | 0.001 | 0.016 | 0.156 |
| | E563SB002 | 563SB00202 | 01/29/1996 | 0.025 | = | | | |
| | E563SB003 | 563SB00302 | 01/29/1996 | 0.008 | = | | | |
| | E563SB004 | 563SB00402 | 01/29/1996 | 0.007 | = | | | |
| | E563SB005 | 563SB00502 | 01/29/1996 | 0.008 | = | | | |

All values are presented in units of milligrams per kilogram (mg/kg).

SSL_{generic} values are from the *EPA Soil Screening Guidance* (EPA, 1996a)

SSL_{unpaved} values are calculated for site- and chemical-specific data (see Table 5-4).

SSL_{paved} values are calculated for site- and chemical-specific data (see Table 5-4).

Bold values exceed the SSL_{unpaved} value.

= Indicates that the compound was detected, the reported concentration is the measured concentration.

NA / Not applicable/not available.

Table 5-4
 Leachate Transport Analysis Model
 RPI Report Addendum, AOC 563, Zone E, Charleston Naval Complex

| | | | Parameter | Methylene chloride |
|---|---|---|--|---|
| Chemical Specific Input Parameters | | | | |
| Cw | = | Target groundwater concentration MCL (mg/L) | | 5.00E-03 |
| H | = | Henry's Law Constant, dimensionless | | 8.98E-02 |
| ks | = | Soil-water sorption coefficient (cm ³ water / g soil = L/kg) = Koc x foc where koc = organic carbon-water sorption coefficient, (cm ³ (ml) water) / (g soluble organic carbon) foc = Fraction of organic content, dimensionless | 0.037 | 4.33E-01 1.17E+01 |
| Site Specific Input Parameters | | | | |
| Sw | = | Width of Source Parallel to Groundwater Flow Direction (impacted soil zone) | 36.6 m | 120 ft |
| da | = | Aquifer Thickness | 7.1 m | 23.25 ft |
| d | = | Groundwater Mixing Zone thickness (paved) | 3.95 m | 13.0 ft |
| | | (unpaved) | 5.07 m | 16.6 ft |
| i | = | Groundwater Gradient | 5.7E-03 | (unitless) |
| Ks | = | Saturated Hydraulic Conductivity | 667.5 m/yr | 2190.0 ft/yr |
| θw | = | Volumetric Water Content of Soil Pore Space | 0.3 cm ³ vapor/cm ³ soil | 0.3 in ³ vapor/in ³ soil |
| θv | = | Volumetric Vapor Content of Soil Pore Space | 0.15 cm ³ vapor/cm ³ soil | 0.15 in ³ vapor/in ³ soil |
| ρs | = | Soil Bulk Density | 1.5 g/cm ³ | 93.64 lb _m /ft ³ |
| qi | = | Water Infiltration Rate (paved) | 0.0086 m/yr | 0.0283 ft/yr |
| | | (unpaved) | 0.1372 m/yr | 0.4500 ft/yr |
| Partition Term, Cw/Csoil, (L/kg) | | | $\frac{C_{soil}}{C_w} = \left(\frac{\theta_w + K_s \rho_s + H \theta_v}{\rho_s} \right) \left(\frac{K_s i d + q_i S_w}{q_i S_w} \right)$ | |
| Dilution Term, dimensionless (paved) | | | 6.42E-01 | |
| (unpaved) | | | 4.87E+01 | |
| Csoil/Cw = Partition term * Dilution term (mg/kg / mg/L) = L/kg (paved) | | | 4.86E+00 | |
| (unpaved) | | | 3.13E+01 | |
| | | | 3.12E+00 | |
| Calculated Site Specific Target Level for Soil | | | | |
| Csoil calculated source soil concentration (SSL, mg/kg) Cw*(partion term)*(dilution term) | | | (paved) | 0.156 |
| | | | (unpaved) | 0.016 |

Cwt is the MCL from EPA National Drinking Water Standards (March 2001) or US EPA Region III RBCs (October, 2000).
 H from Table 36 of the Soil Screening Guidance; Technical Background Document (EPA, 1996).
 ks = koc x foc.
 koc from Table 39 of the Soil Screening Guidance; Technical Background Document (EPA, 1996).
 foc calculated as the mean foc from TOC measurements from Zone E.
 Sw Estimated as the distance along gw flow path (length, NW-SE) of AOC 563 (120 ft).
 d is calculated as $M = (0.0112 L^{-2})^{0.6} + da(1 - e^{-L q_i / K_s da})$ or da, whichever is less.
 da is based on top of Ashley (-20 ft, GIS) and nearest isocontour line for groundwater level (3.25 ft msl, GIS).
 i Calculated from isocontour groundwater map for Zone E ([3.11-2.89]/38.5 ~ 0.005, CH2MHill, 2002).
 Ks Based on CH2MHill's hydraulic conductivity theme in the GIS (6 ft/d).
 θw is the default value presented in the Soil Screening Guidance: User's Guide (EPA, 1996).
 θv is calculated as total porosity (0.45, assumed) - θw (0.3) = 0.15.
 ρs is the default value presented in the Soil Screening Guidance: User's Guide (EPA, 1996).
 qi is a derived value (unpaved, 5.4 in/yr or paved, 0.34 in/yr) based on annual precipitation, evapo-transportation, and runoff coefficient values for the Charleston area.

TABLE 5-5

Calculated Mean Concentration and SSL Comparison for Methylene Chloride in Soil at AOC 563

RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Station ID | Sample ID | Concentration (mg/kg) | Qualifier | Value Used for Mean | Mean Concentration ^a | SSL _{unpaved} (DAF=4.9) | SSL _{paved} (DAF=49) |
|------------|------------|--------------------------|-----------|------------------------|------------------------------------|-------------------------------------|----------------------------------|
| E563SB001 | 563SB00101 | 0.014 | = | 0.014 | 0.008 | 0.016 | 0.156 |
| | 563SB00102 | 0.01 | = | 0.010 | | | |
| E563SB002 | 563SB00201 | 0.016 | = | 0.016 | 0.008 | 0.016 | 0.156 |
| | 563SB00202 | 0.025 | = | 0.025 | | | |
| E563SB003 | 563SB00301 | 0.013 | = | 0.013 | 0.008 | 0.016 | 0.156 |
| | 563SB00302 | 0.008 | = | 0.008 | | | |
| E563SB004 | 563SB00401 | 0.006 | U | 0.003 | 0.007 | 0.016 | 0.156 |
| | 563SB00402 | 0.007 | = | 0.007 | | | |
| E563SB005 | 563SB00501 | 0.006 | U | 0.003 | 0.008 | 0.016 | 0.156 |
| | 563SB00502 | 0.008 | = | 0.008 | | | |
| E563SB006 | 563SB00601 | 0.006 | U | 0.003 | 0.006 | 0.016 | 0.156 |
| | 563SB00602 | 0.006 | U | 0.003 | | | |
| E563SB007 | 563SB00701 | 0.014 | U | 0.007 | 0.006 | 0.016 | 0.156 |
| | 563SB00702 | 0.006 | U | 0.003 | | | |
| E563SB008 | 563SB00801 | 0.006 | U | 0.003 | 0.006 | 0.016 | 0.156 |
| | 563SB00802 | 0.006 | U | 0.003 | | | |
| E563SB009 | 563SB00901 | 0.005 | U | 0.003 | 0.015 | 0.016 | 0.156 |
| | 563SB00902 | 0.015 | U | 0.008 | | | |

All values are presented in units of milligrams per kilogram (mg/kg).

^a Mean concentration was calculated using the reported value for samples where the compound was detected and 1/2 the reported value for non-detects (U and UJ) unless noted. Otherwise, U indicates that the compound was not detected, the reported concentration is the detection limit.

All samples were collected on January 29, 1996.

= Indicates that the compound was detected, the reported concentration is the measured concentration.

TABLE 5-6

Detected Aluminum, Arsenic, Lead, TCE, and Methylene Chloride Concentrations in Groundwater
RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Station ID | Sample ID | Concentration ($\mu\text{g/L}$) | Qualifier | Date Collected |
|-------------------------------------|------------|--------------------------------------|-----------|----------------|
| Aluminum | | | | |
| EPA Region III Tap Water RBC | | 3,700 | | |
| Zone E Range of Conc. | | 19 - 16,100 | | |
| E563GW001 | 563GW00101 | 22,000 | J | 03/28/1996 |
| E563GW001 | 563GW00102 | 2,600 | = | 07/24/1996 |
| E563GW001 | 563GW00103 | 4,940 | J | 11/20/1996 |
| E563GW001 | 563GW00104 | 1,560 | = | 02/04/1997 |
| E563GW002 | 563GW00201 | 356 | J | 03/28/1996 |
| E563GW002 | 563GW00202 | 332 | = | 07/24/1996 |
| E563GW002 | 563GW00203 | 479 | = | 11/22/1996 |
| E563GW002 | 563GW00204 | 388 | = | 02/05/1997 |
| E563GW003 | 563GW00301 | 125 | U | 03/28/1996 |
| E563GW003 | 563GW00302 | 165 | = | 07/31/1996 |
| E563GW003 | 563GW00303 | 255 | = | 11/22/1996 |
| E563GW003 | 563GW00304 | 194 | J | 02/05/1997 |
| E563GW01D | 563GW01D01 | 25 | U | 04/04/1996 |
| E563GW01D | 563GW01D02 | 18 | UJ | 07/24/1996 |
| E563GW01D | 563GW01D03 | 19.9 | J | 11/20/1996 |
| E563GW01D | 563GW01D04 | 18 | U | 02/04/1997 |
| Arsenic | | | | |
| MCL | | 50 | | |
| E563GW001 | 563GW00101 | 34.4 | = | 03/28/1996 |
| E563GW001 | 563GW00102 | 31.8 | = | 07/24/1996 |
| E563GW001 | 563GW00103 | 37.9 | = | 11/20/1996 |
| E563GW001 | 563GW00104 | 25.2 | = | 02/04/1997 |
| E563GW002 | 563GW00201 | 26.7 | = | 03/28/1996 |
| E563GW002 | 563GW00202 | 32.9 | = | 07/24/1996 |
| E563GW002 | 563GW00203 | 36.5 | = | 11/22/1996 |
| E563GW002 | 563GW00204 | 25.2 | = | 02/05/1997 |

TABLE 5-6

Detected Aluminum, Arsenic, Lead, TCE, and Methylene Chloride Concentrations in Groundwater
RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Station ID | Sample ID | Concentration ($\mu\text{g/L}$) | Qualifier | Date Collected |
|----------------|------------|--------------------------------------|-----------|----------------|
| Arsenic | | | | |
| MCL | | 50 | | |
| E563GW003 | 563GW00301 | 5.8 | J | 03/28/1996 |
| E563GW003 | 563GW00302 | 2.5 | U | 07/31/1996 |
| E563GW003 | 563GW00303 | 2.5 | U | 11/22/1996 |
| E563GW003 | 563GW00304 | 2.5 | U | 02/05/1997 |
| E563GW01D | 563GW01D01 | 5 | U | 04/04/1996 |
| E563GW01D | 563GW01D02 | 3.4 | U | 07/24/1996 |
| E563GW01D | 563GW01D03 | 6.4 | J | 11/20/1996 |
| E563GW01D | 563GW01D04 | 2.9 | J | 02/04/1997 |
| Lead | | | | |
| MCL | | 15 | | |
| E563GW001 | 563GW00101 | 17.6 | = | 03/28/1996 |
| E563GW001 | 563GW00102 | 5.1 | U | 07/24/1996 |
| E563GW001 | 563GW00103 | 13.6 | = | 11/20/1996 |
| E563GW001 | 563GW00104 | 3.1 | = | 02/04/1997 |
| E563GW002 | 563GW00201 | 3 | U | 03/28/1996 |
| E563GW002 | 563GW00202 | 1.7 | U | 07/24/1996 |
| E563GW002 | 563GW00203 | 1.7 | UJ | 11/22/1996 |
| E563GW002 | 563GW00204 | 1.7 | U | 02/05/1997 |
| E563GW003 | 563GW00301 | 3 | U | 03/28/1996 |
| E563GW003 | 563GW00302 | 1.7 | U | 07/31/1996 |
| E563GW003 | 563GW00303 | 1.7 | UJ | 11/22/1996 |
| E563GW003 | 563GW00304 | 1.7 | U | 02/05/1997 |
| E563GW01D | 563GW01D01 | 3 | U | 04/04/1996 |
| E563GW01D | 563GW01D02 | 1.7 | U | 07/24/1996 |
| E563GW01D | 563GW01D03 | 1.7 | U | 11/20/1996 |
| E563GW01D | 563GW01D04 | 1.7 | U | 02/04/1997 |

TABLE 5-6

Detected Aluminum, Arsenic, Lead, TCE, and Methylene Chloride Concentrations in Groundwater
RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Station ID | Sample ID | Concentration ($\mu\text{g/L}$) | Qualifier | Date Collected |
|---------------------------|-------------|--------------------------------------|-----------|----------------|
| TCE | | | | |
| MCL | | 5 | | |
| E563GW001 | 563GW00101 | 5 | U | 03/28/1996 |
| E563GW001 | 563GW00102 | 6 | = | 07/24/1996 |
| E563GW001 | 563GW00103 | 14 | = | 11/20/1996 |
| E563GW001 | 563GW00104 | 10 | = | 02/04/1997 |
| E563GW001 | 563GW00101a | 5 | S= | 03/10/1998 |
| E563GW001 | 563GW00102a | 5 | SU | 10/13/1998 |
| E563GW002 | 563GW00201 | 5 | U | 03/28/1996 |
| E563GW002 | 563GW00202 | 5 | = | 07/24/1996 |
| E563GW002 | 563GW00203 | 6 | = | 11/22/1996 |
| E563GW002 | 563GW00204 | 6 | = | 02/05/1997 |
| E563GW002 | 563GW00201a | 3 | SJ | 03/10/1998 |
| E563GW002 | 563GW00202a | 3 | SJ | 10/13/1998 |
| E563GW003 | 563GW00301 | 120 | = | 03/28/1996 |
| E563GW003 | 563GW00302 | 120 | = | 07/31/1996 |
| E563GW003 | 563GW00303 | 100 | = | 11/22/1996 |
| E563GW003 | 563GW00304 | 44 | = | 02/05/1997 |
| E563GW003 | 563GW00301a | 12 | S= | 03/10/1998 |
| E563GW003 | 563GW00302a | 5 | SU | 10/13/1998 |
| E563GW01D | 563GW01D01 | 5 | U | 04/04/1996 |
| E563GW01D | 563GW01D02 | 5 | U | 07/24/1996 |
| E563GW01D | 563GW01D03 | 5 | U | 11/20/1996 |
| E563GW01D | 563GW01D04 | 5 | U | 02/04/1997 |
| E563GW01D | 563GW01D01a | 5 | SU | 03/10/1998 |
| E563GW01D | 563GW01D02a | 5 | SU | 10/13/1998 |
| Methylene Chloride | | | | |
| MCL | | 5 | | |
| E563GW001 | 563GW00101 | 5 | U | 03/28/1996 |

TABLE 5-6

Detected Aluminum, Arsenic, Lead, TCE, and Methylene Chloride Concentrations in Groundwater
 RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Station ID | Sample ID | Concentration ($\mu\text{g/L}$) | Qualifier | Date Collected |
|---------------------------|-------------|--------------------------------------|-----------|----------------|
| Methylene Chloride | | | | |
| | MCL | 5 | | |
| E563GW001 | 563GW00102 | 5 | U | 07/24/1996 |
| E563GW001 | 563GW00103 | 7 | = | 11/20/1996 |
| E563GW001 | 563GW00104 | 5 | U | 02/04/1997 |
| E563GW001 | 563GW00101a | 5 | SU | 03/10/1998 |
| E563GW001 | 563GW00102a | 5 | SU | 10/13/1998 |
| E563GW002 | 563GW00201 | 5 | U | 03/28/1996 |
| E563GW002 | 563GW00202 | 5 | U | 07/24/1996 |
| E563GW002 | 563GW00203 | 5 | U | 11/22/1996 |
| E563GW002 | 563GW00204 | 5 | U | 02/05/1997 |
| E563GW002 | 563GW00201a | 5 | SU | 03/10/1998 |
| E563GW002 | 563GW00202a | 5 | SU | 10/13/1998 |
| E563GW003 | 563GW00301 | 17 | U | 03/28/1996 |
| E563GW003 | 563GW00302 | 5 | U | 07/31/1996 |
| E563GW003 | 563GW00303 | 6 | U | 11/22/1996 |
| E563GW003 | 563GW00304 | 5 | U | 02/05/1997 |
| E563GW003 | 563GW00301a | 5 | SU | 03/10/1998 |
| E563GW003 | 563GW00302a | 5 | SU | 10/13/1998 |
| E563GW01D | 563GW01D01 | 6 | U | 04/04/1996 |
| E563GW01D | 563GW01D02 | 5 | U | 07/24/1996 |
| E563GW01D | 563GW01D03 | 2 | J | 11/20/1996 |
| E563GW01D | 563GW01D04 | 5 | U | 02/04/1997 |
| E563GW01D | 563GW01D01a | 5 | SU | 03/10/1998 |
| E563GW01D | 563GW01D02a | 5 | SU | 10/13/1998 |

All values are presented in units of micrograms per liter ($\mu\text{g/L}$).

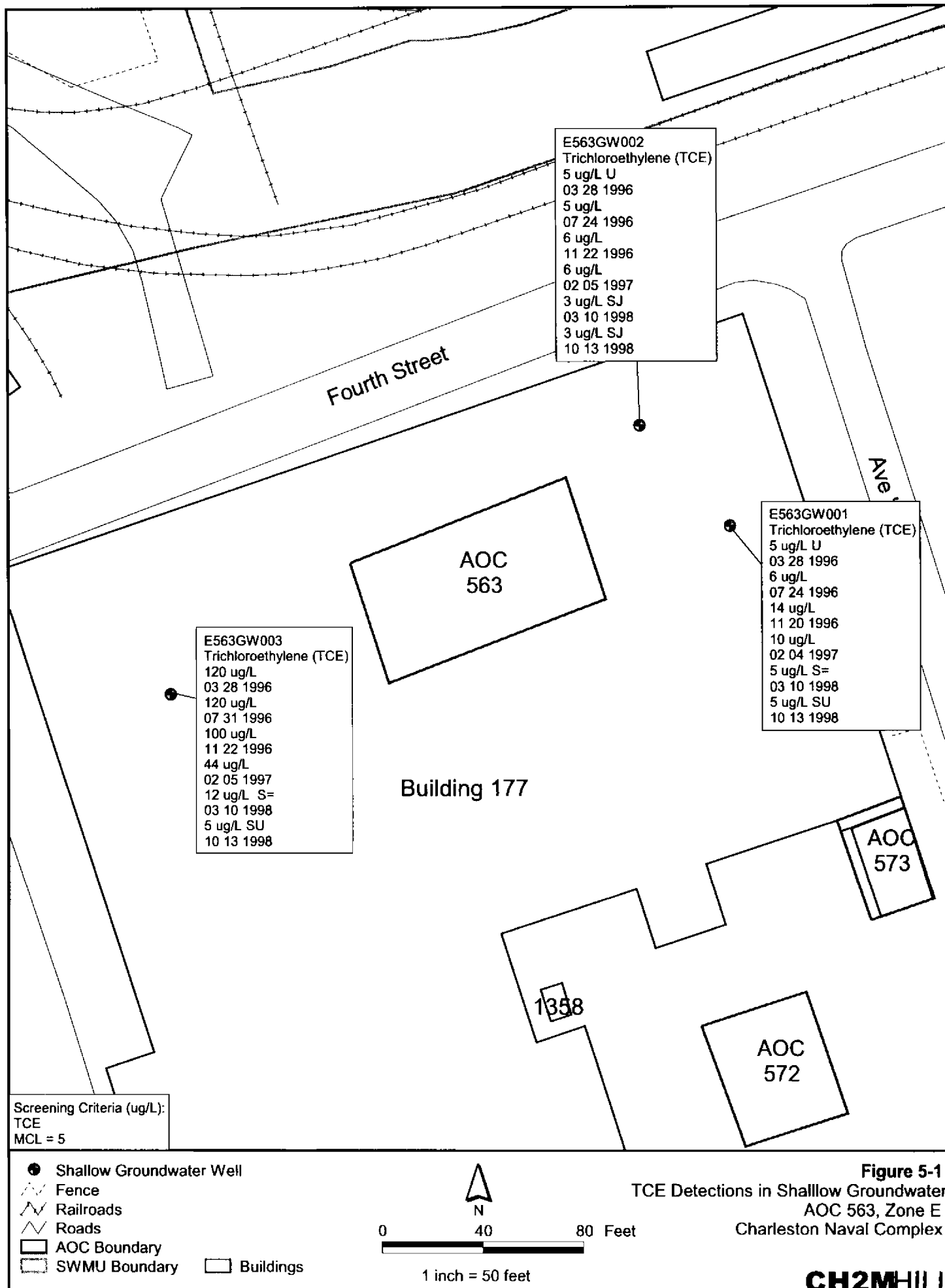
Concentrations in bold text and outlined within the table represent exceedances of the appropriate screening criteria.

- = Indicates that the analyte was detected at the concentration shown.
- J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.

TABLE 5-6

Detected Aluminum, Arsenic, Lead, TCE, and Methylene Chloride Concentrations in Groundwater
RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

| Station ID | Sample ID | Concentration ($\mu\text{g/L}$) | Qualifier | Date Collected |
|------------|---|--------------------------------------|-----------|----------------|
| MCL | Maximum Contaminant Level | | | |
| S | Indicates that the data has not been validated but can be used for screening purposes. | | | |
| S= | Indicates that the analyte was detected at the concentration shown, used for screening purposes only. | | | |
| SU | Indicates that the analyte was not detected, used for screening purposes only. | | | |
| U | Indicates that the analyte was not detected. | | | |



6.0 Summary of Information Related to Site Closeout Issues

6.1 RFI Status

The *Zone E RFI Report, Revision 0* (EnSafe, 1997) addressed SWMUs/ AOCs within Zone E of the CNC, including AOC 563.

The RFI for AOC 563 identified COCs for surface soils and shallow groundwater. Based on the discussion presented in Section 5.0 above, only TCE in shallow groundwater has been retained as a COC at AOC 563. A focused CMS is proposed for this site, and Section 8.0 presents a CMS Work Plan. The remaining subsections address the issues that the BCT agreed to evaluate prior to site closeout.

6.2 Presence of Inorganics in Groundwater

For the purpose of site closeout documentation, the inorganics in groundwater issue refers to the occasional or intermittent detection of several metals (primarily arsenic, thallium, and antimony) in groundwater at concentrations above the applicable MCL, preceded or followed by detections of these same metals below the MCL or below the practicable quantitation limit.

There were no detections of antimony or thallium in shallow or deep wells above the laboratory detection limits. There were no detections of arsenic above the MCL determined for the State of South Carolina in samples from the shallow or deep groundwater monitoring wells. Therefore, further evaluation of this issue is not warranted.

6.3 Potential Linkage to SWMU 37, Investigated Sanitary Sewers at the CNC

There are no data suggesting that there was an impact to the sanitary sewers from this site. Therefore, further evaluation of this issue is not warranted.

6.4 Potential Linkage to AOC 699, Investigated Storm Sewers at the CNC

No direct impact from this site to the investigated storm sewers is known to exist.
Therefore, no further evaluation for this issue is warranted.

6.5 Potential Linkage to AOC 504, Investigated Railroad Lines at the CNC

The nearest existing railroad line to AOC 563 is approximately 100 feet north of the site.
There is no known linkage between AOC 563 and the investigated railroad lines of AOC 504, so further evaluation of this issue is not warranted.

6.6 Potential Migration Pathways to Surface Water Bodies at the CNC

The nearest surface water body to AOC 563 is the Cooper River, which lies approximately 600 feet northeast of the site. The only potential migration pathway from the site to surface water is via overland flow via stormwater runoff. The entire site is covered with buildings and pavement, which eliminates any contact of surface soil with stormwater. Similarly, runoff directed to the storm sewer system, which discharges to the Cooper River, does not come in contact with the surface soil. Because the site is currently located beneath Building 177, no further evaluation of a potential pathway for contaminant migration via stormwater runoff is warranted.

6.7 Potential Contamination in Oil/Water Separators (OWSs)

There is no indication of OWSs associated with AOC 563 according to the *Oil Water Separator Data* document, issued by the Department of the Navy, September 2000. Therefore, further evaluation of this issue is not warranted.

6.8 Land Use Controls (LUCs)

The CNC BCT has agreed that LUCs will be applied across all of Zone E at the CNC. These LUCs are expected to include, at a minimum, restrictions for future land use to non-residential use only. These LUCs will be applied to AOC 563 due to its location within Zone E.

1 **7.0 Recommendations**

2 AOC 563 is former Building 37, a locomotive maintenance house constructed in 1913 and
3 used until 1939. According the RFA, probable maintenance activities involved petroleum-
4 based lubricants, chlorinated solvents and degreasers, and coal or petroleum fuels. Building
5 177 is currently on the site of former Building 37. Building 177 is currently being used for
6 storage and equipment maintenance activities in support of the operations by Detyens
7 Shipyards, Inc.

8 The *Zone E RFI Report, Revision 0* (EnSafe, 1997) identified BEQs in surface soils, and
9 aluminum, arsenic, lead, and TCE in shallow groundwater as COCs for the AOC 563 site.
10 Based on an evaluation of the data and site conditions as presented herein, only TCE in
11 shallow groundwater is retained as a COC for the site. This RFI Report Addendum
12 recommends that a focused CMS be undertaken to address TCE in shallow groundwater at
13 AOC 563. No other COCs were identified for any other media at this site. A CMS Work Plan
14 for conducting a focused CMS is provided in Section 8.0 of this report.

8.0 CMS Work Plan

TCE was identified as a COC in shallow groundwater at AOC 563. Currently the groundwater at the CNC is not used as a source of potable water. However, it is feasible that in the future, should land use and/or site conditions change, some exposure could occur. Therefore, a CMS should be conducted to evaluate potential corrective measures and identify an appropriate remedy for the site. An additional investigation to better characterize the extent of TCE in groundwater at AOC 563 is proposed. A Sampling and Analysis Plan (SAP) will be prepared and submitted to SCDHEC for this purpose as part of the CMS phase of the RCRA CA program.

This section presents a focused CMS Work Plan. Media cleanup standards (MCSs) are identified in this section for COCs, as well as the potential remedies that should be evaluated.

8.1 Remedial Action Objectives

Remedial action objectives (RAOs) are medium-specific goals that the remedial actions are designed to accomplish in order to protect human health and the environment by preventing or reducing exposures under current and future land use conditions. The RAOs identified for the groundwater at AOC 563 are 1) to prevent ingestion and direct/dermal contact with groundwater having unacceptable carcinogenic or noncarcinogenic risk, and 2) to restore the aquifer to beneficial use. No remedial actions are required for surface or subsurface soil at AOC 563.

8.2 Remedial Goal Options and Media Cleanup Standards

Throughout the process of remediating a hazardous waste site, a risk manager uses a progression of increasingly acceptable site-specific media levels in considering remedial alternatives. Under the RCRA program, remedial goal options (RGOs) and MCSs are developed at the end of the risk assessment in the RFI/Remedial Investigation (RI) programs, before completion of the CMS.

RGOs can be based on a variety of criteria, such as specific incremental lifetime cancer risk (ILCR) levels (e.g., 1E-04, 1E-05, or 1E-06), HI levels (e.g., 0.1, 1.0, 3.0), or site background concentrations. For a particular RGO, specific MCSs can be determined as target concentration values. Achieving these MCSs is accepted as demonstrating that RGOs and

RAOs have been achieved. Achieving these goals should promote the protection of human health and the environment, while achieving compliance with applicable state and federal standards.

The exposure media of concern for AOC 563 is TCE-contaminated shallow groundwater. Because AOC 563 is located within a highly developed area of the CNC and there are no surface water bodies in the immediate vicinity of the site, ecological exposures were not considered applicable for evaluation.

TCE was the only COC identified for the groundwater, and was detected at concentrations ranging from 5 to 120 $\mu\text{g/L}$. The MCS/RGOs are the MCL (5 $\mu\text{g/L}$) for TCE.

8.3 Potential Remedies to Evaluate

The remedies that are candidates to be evaluated as part of the CMS include:

- Natural attenuation with LUCs.
- In situ treatment of a source area, if present, and natural attenuation of the remaining dissolved plume.

Other remedial alternatives may be identified based on additional data obtained during further characterization activities.

8.4 Focused CMS Approach

The focused CMS will consist of the following tasks that will be performed in the order presented below:

1. The candidate corrective measure alternatives described above will be screened using several criteria and decision factors.
2. A preferred corrective measure alternative will be selected.
3. The CMS and preferred corrective measure alternative will be documented in the CMS report.

8.5 Approach to Evaluating Corrective Measure Alternatives

According to the RCRA permit issued by SCDHEC (SCDHEC, 1998), the alternatives will be evaluated with the following five standards:

1. Protecting human health and the environment.
2. Attaining media cleanup standards (RGOs).

3. Controlling the source of releases to minimize future releases that may pose a threat to human health and the environment.
4. Complying with applicable standards for the management of wastes generated by remedial activities.
5. Other factors include (a) long-term reliability and effectiveness; (b) reduction in toxicity, mobility, or volume of wastes; (c) short-term effectiveness; (d) implementability; and (e) cost.

Each of the five standards is defined in more detail below:

1. **Protecting human health and the environment.** The alternatives will be evaluated on the basis of their ability to protect human health and the environment. The ability of an alternative to achieve this standard may or may not be independent of its ability to achieve the other four standards. For example, an alternative may be protective of human health, but may not be able to attain the MCSs if the MCSs are not directly tied to protecting human health.
2. **Attaining media cleanup standards (RGOs).** The alternatives will be evaluated on the basis of their ability to achieve the RGOs defined in this CMS Work Plan. Another aspect of this standard is the timeframe to achieve the RGOs. Estimates of the timeframe for the alternatives to achieve RGOs will be provided.
3. **Controlling the source of releases.** This standard deals with the control of releases of contamination from the source (the area in which the contamination originated).
4. **Complying with applicable standards for management of wastes.** This standard deals with the management of wastes derived from implementing the alternatives, for example, treatment or disposal of excavated material. The soil removal alternative will be designed to comply with all applicable standards for management of remediation wastes. Consequently, this standard will not be explicitly included in the detailed evaluation presented in the CMS but will be part of a work plan specific to the removal action should a removal action become the chosen alternative.
5. **Other factors.** Five other factors are to be considered if an alternative is found to meet the four standards described above. These other factors are as follows:
 - a. Long-term reliability and effectiveness
The two alternatives will be evaluated on the basis of their reliability, and the potential impact should the chosen alternative fail. In other words, a qualitative

assessment will be made as to the chance of the alternative's failure and the consequences of that failure.

b. Reduction in the toxicity, mobility, or volume of wastes

Alternatives with technologies that reduce the toxicity, mobility, or volume of the contamination will be generally favored over those that do not. Consequently, a qualitative assessment of this factor will be performed for each alternative.

c. Short-term effectiveness

Alternatives will be evaluated on the basis of the risk they create during the implementation of the remedy. Factors that may be considered include fire, explosion, and exposure of workers to hazardous substances.

d. Implementability

The alternatives will be evaluated for their implementability by considering any difficulties associated with conducting the alternatives (such as the construction disturbances they may create), operation of the alternatives, and the availability of equipment and resources to implement the technologies comprising the alternatives.

e. Cost

A net present value of each alternative will be developed. These cost estimates will be used for the relative evaluation of the alternatives, not to bid or budget the work. The estimates will be based on information available at the time of the CMS and on a conceptual design of the alternative. They will be "order-of-magnitude" estimates with a generally expected accuracy of -50 percent to +50 percent for the scope of action described for each alternative. The estimates will be categorized into capital costs and operations and maintenance costs for each alternative.

In addition to the criteria described above, the alternatives will be evaluated for their ability to achieve all contractual obligations of CH2M-Jones and the Navy.

8.6 Focused CMS Report

A focused CMS Report will be prepared to present the identification, development, and evaluation of potential corrective measures for AOC 563. A proposed outline of the report, as shown in Table 8-1, provides an example of the report format and content.

TABLE 8-1
 Outline of Focused CMS Report for AOC 563
RFI Report Addendum and CMS Work Plan, AOC 563, Zone E, Charleston Naval Complex

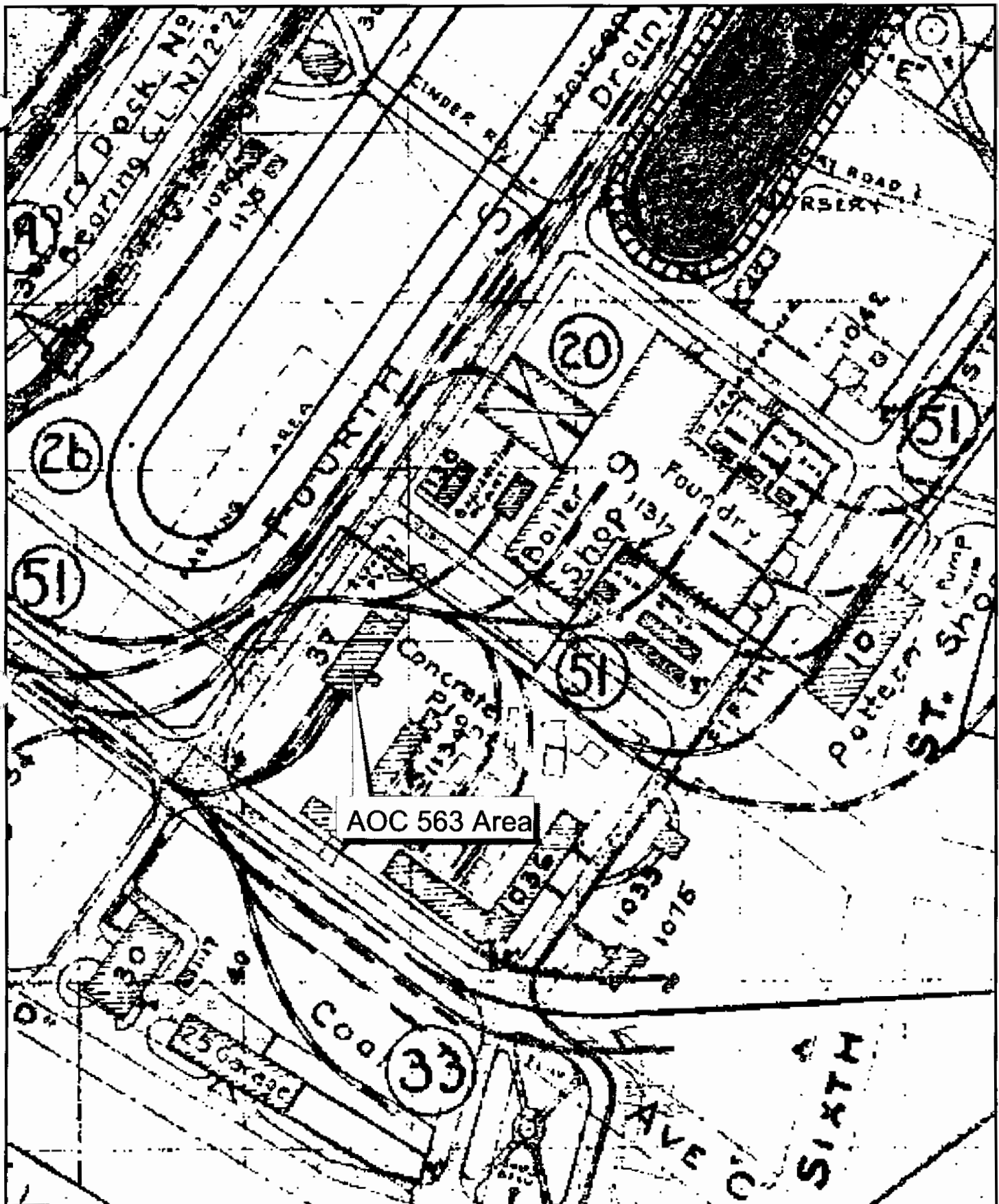
| Section No. | Section Title |
|-------------------|--|
| 1.0 | Introduction |
| 1.1 | Corrective Measures Study Purpose and Scope |
| 1.2 | Report Organization |
| 1.3 | Background Information |
| 1.3.1 | Facility Description |
| 1.3.2 | Site History and Background |
| 1.3.2.1 | Nature and Extent of Contamination |
| 1.3.2.2 | Summary of Risk Assessment |
| 2.0 | Remedial Goal Objectives |
| 3.0 | Detailed Analysis of Focused Alternatives |
| 3.1 | Approach |
| 3.2 | Evaluation Criteria |
| 3.3 | Description of Alternatives |
| 3.3.1 | Alternative 1: Natural attenuation with LUCs |
| 3.3.2 | Alternative 2: In situ Treatment of Contaminated Groundwater |
| 3.4 | Detailed Analysis of Alternatives |
| 3.4.1 | Analysis of Alternative 1 |
| 3.4.2 | Analysis of Alternative 2 |
| 3.5 | Comparative Analysis of Alternatives |
| 4.0 | Recommended Remedial Alternative |
| 5.0 | References |
| Appendix A | Corrective Measure Alternative Cost Estimates^b |
| List of Tables | |
| List of Figures | |

^a Additional alternatives will be analyzed as found necessary.

^b Additional appendices will be added, if necessary.

1 9.0 References

- 2 CH2M-Jones. *Technical Memorandum: A Summary of Inorganic Chemical Concentrations in*
3 *Background Soil and Groundwater at the CNC*. February 2001.
- 4 EnSafe Inc. *Zone E RFI Report, Revision 0, NAVBASE Charleston*. November 1997.
- 5 EnSafe Inc./Allen & Hoshall. *Final RCRA Facility Assessment Report, NAVBASE Charleston*.
6 June 6, 1995a.
- 7 EnSafe Inc./Allen & Hoshall. *Final Zone E RFI Work Plan, Revision 1, NAVBASE Charleston*.
8 June 1995b.
- 9 South Carolina Department of Health and Environmental Control, Final RCRA Part B
10 Permit No. SC0 170 022 560.
- 11 U.S. Environmental Protection Agency. *EPA Soil Screening Guidance: Technical Background*
12 *Document* (Table A-1), EPA/540/R-95/128. May 1996a.
- 13 U.S. Environmental Protection Agency. *EPA Soil Screening Guidance: User's Guide*. EPA/Pub.
14 No. 9355.4-23. July 1996b.
- 15 U.S. Navy. *Oil/Water Separator Data*. September 2000.



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Responses to Comments from Eric F. Cathcart, SCDHEC

Site Specific Comments

AOC 563

SCDHEC Comment 54

Trichloroethene in shallow groundwater at AOC 563 has not been fully delineated both horizontally or vertically. Additional groundwater samples should be proposed.

Navy/EnSafe Response:

The Navy recognizes the TCE problem in shallow groundwater at this site. However, analytical results for shallow monitoring wells to the west at AOCs 569 and 570 do not indicate significant concentrations of TCE. Also, results from shallow wells to the south at AOCs 572 and 573 and from wells to the east at SWMUs 83, 84 and AOC 574 do not indicate elevated concentrations of TCE. Elevated concentrations of TCE have been detected in deep groundwater to the west at AOC 570 (NBCE57003D), consistently exceeding its MCL, but as previously mentioned, this particular constituent has been identified at elevated concentrations at several sites and in deep grid wells throughout the northern portion of Zone E. Analytical results from this area will be evaluated and the Navy will discuss additional well locations with the Project Team.

CH2M-Jones Response:

A focused groundwater investigation, as part of the Corrective Measures Study (CMS) phase is being proposed to obtain additional information about the extent of chlorinated solvent contamination in the vicinity of this site in Zone E.

SCDHEC Comment 55

The first sentence in the third paragraph on page 10.31-18 should be revised. 1,2-Dichloroethene (total) was also detected in shallow groundwater at a concentration exceeding its corresponding tap water RBC.

Navy/EnSafe Response:

This sentence will be revised to include 1,2-Dichloroethene in the Final Zone E RFI Report.

CH2M-Jones Response:

1,2-Dichloroethene was addressed in the risk evaluation in the RFI Report and was not retained as a COC in shallow groundwater at AOC 563 because it did not exceed its drinking water MCL.

Chemicals Detected in Zone E Soil Samples
AOC 563

| Name | ID | Surface Conc. | Subsurface Conc. | RBC (THQ=.1) | Surface UTL | Subsurface UTL * |
|--|----------|------------------|---------------------|-----------------|----------------|---------------------|
| <i>Volatile Organic Compounds (ug/kg)</i> | | | | | | |
| Acetone | 563SB005 | 72.00 | ND | 780000.00 | NA | NA |
| Methylene chloride | 563SB001 | 14.00 | 10.00 | 85000.00 | | |
| | 563SB002 | 16.00 | 25.00 | | | |
| | 563SB003 | 13.00 | 8.00 | | | |
| | 563SB004 | ND | 7.00 | | | |
| | 563SB005 | ND | 8.00 | | | |
| Trichloroethene | 563SB003 | 2.00 | ND | 58000.00 | NA | NA |
| <i>Semi-volatile Compounds (ug/kg)</i> | | | | | | |
| Benzo(a)anthracene | 563SB002 | ND | 80.00 | 880.00 | NA | NA |
| | 563SB003 | 100.00 | ND | | | |
| | 563SB007 | 55.00 | 47.00 | | | |
| Benzo(a)pyrene | 563SB002 | ND | 71.00 | 88.00 | NA | NA |
| | 563SB003 | 110.00 | ND | | | |
| | 563SB007 | 52.00 | 61.00 | | | |
| Benzo(b)fluoranthene | 563SB001 | 54.00 | ND | 880.00 | NA | NA |
| | 563SB002 | ND | 58.00 | | | |
| | 563SB003 | 110.00 | ND | | | |
| | 563SB007 | 72.50 | 90.00 | | | |
| | 563SB008 | 40.00 | ND | | | |
| Benzo(g,h,i)perylene | 563SB002 | ND | 58.00 | 310000.00 | NA | NA |
| | 563SB003 | 59.00 | ND | | | |
| | 563SB007 | 47.00 | 64.00 | | | |
| Benzo(k)fluoranthene | 563SB002 | ND | 98.00 | 8800.00 | NA | NA |
| | 563SB003 | 98.00 | ND | | | |
| | 563SB006 | 45.00 | ND | | | |
| | 563SB007 | 56.00 | 95.00 | | | |
| | 563SB008 | 47.00 | ND | | | |
| | 563SB009 | ND | 44.00 | | | |
| Benzoic acid | 563SB006 | 76.00 | ND | 31000000.00 | NA | NA |
| Benzyl alcohol | 563SB006 | 39.00 | ND | 2300000.00 | NA | NA |
| Butylbenzylphthalate | 563SB006 | 7200.00 | 740.00 | 1600000.00 | NA | NA |
| Chrysene | 563SB001 | 55.00 | ND | 88000.00 | NA | NA |
| | 563SB002 | 100.00 | ND | | | |
| | 563SB003 | 120.00 | 43.00 | | | |
| | 563SB006 | 51.00 | ND | | | |
| | 563SB007 | 68.00 | 100.00 | | | |
| | 563SB008 | 49.00 | ND | | | |
| | 563SB009 | ND | 46.00 | | | |
| | 563SB001 | 60.00 | ND | 3100000.00 | NA | NA |
| | 563SB002 | ND | 120.00 | | | |
| Fluoranthene | 563SB003 | 170.00 | 51.00 | | | |
| | 563SB006 | 60.00 | ND | | | |
| | 563SB007 | 55.50 | 72.00 | | | |
| | 563SB002 | ND | 44.00 | 880.00 | NA | NA |
| | 563SB003 | 57.00 | ND | | | |
| | 563SB007 | 41.00 | 53.00 | | | |
| Phenanthrene | 563SB001 | 42.00 | ND | 310000.00 | NA | NA |
| | 563SB002 | ND | 84.00 | | | |
| | 563SB003 | 60.00 | ND | | | |

**Chemicals Detected in Zone E Soil Samples
AOC 563**

| Name | ID | Surface Conc. | Subsurface Conc. | RBC (THQ=.1) | Surface UTL | Subsurface UTL * |
|-----------------------------------|----------|------------------|---------------------|-----------------|----------------|---------------------|
| Pyrene | 563SB006 | 40.00 | ND | 230000.00 | NA | NA |
| | 563SB001 | 78.00 | ND | | | |
| | 563SB002 | ND | 140.00 | | | |
| | 563SB003 | 200.00 | 64.00 | | | |
| | 563SB006 | 75.00 | ND | | | |
| | 563SB007 | 76.00 | 86.00 | | | |
| | 563SB008 | 49.00 | ND | | | |
| | 563SB009 | ND | 46.00 | | | |
| | 563SB001 | 71.00 | ND | | | |
| bis(2-Ethylhexyl)phthalate (BEHP) | 563SB002 | 44.00 | 46.00 | 4600.00 | NA | NA |
| | 563SB003 | 140.00 | ND | | | |
| | 563SB004 | 47.00 | ND | | | |
| | 563SB006 | 13000.00 | 2683.00 | | | |
| | 563SB007 | 3150.00 | 1400.00 | | | |
| | 563SB008 | 54.00 | 54.00 | | | |
| | 563SB009 | 100.00 | 49.00 | | | |

Chlorinated Pesticides (ug/kg)

| | | | | | | |
|-----------------|----------|-------|-------|---------|----|----|
| 4,4'-DDD | 563SB005 | 11.00 | 6.50 | 2700.00 | NA | NA |
| | 563SB008 | 3.90 | ND | | | |
| 4,4'-DDE | 563CB007 | 8.30 | ND | 1900.00 | NA | NA |
| | 563SB002 | ND | 5.20 | | | |
| | 563SB003 | 3.00 | ND | | | |
| | 563SB004 | 3.10 | ND | | | |
| | 563SB005 | 30.00 | 47.00 | | | |
| | 563SB006 | 8.70 | ND | | | |
| | 563SB007 | 3.10 | ND | | | |
| | 563SB008 | 44.00 | 7.20 | | | |
| | 563SB009 | 5.70 | ND | | | |
| 4,4'-DDT | 563CB007 | 9.70 | ND | 1900.00 | NA | NA |
| | 563SB002 | 7.70 | ND | | | |
| | 563SB003 | 6.20 | 4.40 | | | |
| | 563SB004 | 48.00 | 5.70 | | | |
| | 563SB005 | 52.00 | 30.00 | | | |
| | 563SB006 | 11.00 | ND | | | |
| | 563SB007 | 12.00 | 7.50 | | | |
| | 563SB008 | 20.00 | 7.00 | | | |
| | 563SB009 | 7.40 | ND | | | |
| Endrin aldehyde | 563SB008 | 3.90 | ND | 2300.00 | NA | NA |
| alpha-Chlordane | 563SB002 | ND | 2.10 | 490.00 | NA | NA |

Polychlorinated biphenyls (ug/kg)

| | | | | | | |
|--------------|----------|----|--------|-------|----|----|
| Aroclor-1260 | 563SB009 | ND | 190.00 | 83.00 | NA | NA |
|--------------|----------|----|--------|-------|----|----|

Dioxin/Dibenzofuran (ng/kg)

| | | | | | | |
|---------------|----------|------|------|----|----|----|
| 1234678-HpCDD | 563CB007 | 4.70 | NS | NA | NA | NA |
| | 563CB006 | ND | 3.17 | | | |
| 1234678-HpCDF | 563CB007 | 2.05 | NS | NA | NA | NA |
| | 563CB006 | ND | 1.71 | | | |
| 123478-HxCDF | 563CB007 | 2.81 | NS | NA | NA | NA |
| | 563CB006 | ND | 6.67 | | | |

Chemicals Detected in Zone E Soil Samples
AOC 563

| Name | ID | Surface Conc. | Subsurface Conc. | RBC (THQ=.1) | Surface UTL | Subsurface UTL * |
|---------------------|----------|------------------|---------------------|-----------------|----------------|---------------------|
| 234678-HxCDF | 563CB006 | ND | 6.41 | NA | NA | NA |
| 23478-PeCDF | 563CB006 | ND | 3.21 | NA | NA | NA |
| 2378-TCDF | 563CB007 | 3.43 | NS | NA | NA | NA |
| | 563CB006 | ND | 9.85 | | | |
| OCDD | 563CB007 | 102.00 | NS | NA | NA | NA |
| | 563CB006 | ND | 98.80 | | | |
| OCDF | 563CB007 | 1.48 | NS | NA | NA | NA |
| | 563CB006 | ND | 1.20 | | | |
| Total Hepta-Dioxins | 563CB006 | ND | 6.51 | NA | NA | NA |
| | 563CB007 | 10.30 | NS | | | |
| Total Hepta-Furans | 563CB006 | ND | 2.83 | NA | NA | NA |
| | 563CB007 | 2.05 | NS | | | |
| Total Hexa-Dioxins | 563CB007 | 2.22 | NS | NA | NA | NA |
| Total Hexa-Furans | 563CB006 | ND | 5.78 | NA | NA | NA |
| | 563CB007 | 2.81 | NS | | | |
| Total Penta-Furans | 563CB006 | ND | 21.80 | NA | NA | NA |
| | 563CB007 | 2.78 | NS | | | |
| Total Tetra-Furans | 563CB006 | ND | 24.10 | NA | NA | NA |
| | 563CB007 | 3.43 | NS | | | |

Inorganic Compounds (mg/kg)

| | | | | | | |
|---------------|----------|----------|----------|---------|----------|----------|
| Aluminum (Al) | 563SB001 | 6280.00 | 9690.00 | 7800.00 | 26000.00 | 41100.00 |
| | 563SB002 | 9220.00 | 5360.00 | | | |
| | 563SB003 | 7040.00 | 5410.00 | | | |
| | 563SB004 | 12200.00 | 11400.00 | | | |
| | 563SB005 | 8790.00 | 11200.00 | | | |
| | 563SB006 | 10000.00 | 10750.00 | | | |
| | 563SB007 | 9100.00 | 13100.00 | | | |
| | 563SB008 | 5480.00 | 7490.00 | | | |
| | 563SB009 | 5080.00 | 6680.00 | | | |
| Antimony (Sb) | 563SB001 | ND | 0.49 | 3.10 | 1.77 | 1.60 |
| | 563SB002 | ND | 0.53 | | | |
| | 563SB003 | 0.51 | ND | | | |
| | 563SB004 | 0.66 | ND | | | |
| | 563SB005 | 0.54 | ND | | | |
| | 563SB006 | 0.58 | 0.59 | | | |
| | 563SB007 | 0.55 | 1.20 | | | |
| Arsenic (As) | 563SB001 | 5.00 | 9.10 | 0.43 | 23.90 | 19.90 |
| | 563SB002 | 5.60 | 8.30 | | | |
| | 563SB003 | 3.90 | 2.60 | | | |
| | 563SB004 | 8.00 | 6.40 | | | |
| | 563SB005 | 7.10 | 4.70 | | | |
| | 563SB006 | 9.90 | 6.05 | | | |
| | 563SB007 | 5.15 | 10.80 | | | |
| | 563SB008 | 3.30 | 5.90 | | | |
| | 563SB009 | 3.00 | 3.00 | | | |
| Barium (Ba) | 563SB001 | 20.60 | 26.80 | 550.00 | 130.00 | 94.10 |
| | 563SB002 | 112.00 | 32.10 | | | |
| | 563SB003 | 38.40 | 26.90 | | | |
| | 563SB004 | 65.80 | 50.40 | | | |
| | 563SB005 | 28.70 | 44.70 | | | |

**Chemicals Detected in Zone E Soil Samples
AOC 563**

| Name | ID | Surface Conc. | Subsurface Conc. | RBC (THQ=.1) | Surface UTL | Subsurface UTL * |
|----------------|-----------|--------------------------|-----------------------------|-------------------------|------------------------|-----------------------------|
| Beryllium (Be) | 563SB006 | 33.80 | 33.25 | 0.15 | 1.70 | 2.71 |
| | 563SB007 | 34.70 | 33.80 | | | |
| | 563SB008 | 40.30 | 64.60 | | | |
| | 563SB009 | 35.40 | 37.70 | | | |
| | 563SB001 | 0.19 | 0.30 | | | |
| | 563SB002 | 0.28 | 0.23 | | | |
| | 563SB003 | 0.30 | 0.21 | | | |
| | 563SB004 | 0.39 | 0.39 | | | |
| | 563SB005 | 0.27 | 0.36 | | | |
| | 563SB006 | 0.41 | 0.28 | | | |
| Cadmium (Cd) | 563SB007 | 0.33 | 0.60 | 3.90 | 1.50 | 0.96 |
| | 563SB008 | 0.28 | 0.35 | | | |
| | 563SB009 | 0.34 | 0.34 | | | |
| | 563SB001 | 0.17 | 0.22 | | | |
| | 563SB002 | 0.12 | 0.37 | | | |
| | 563SB003 | 0.28 | ND | | | |
| | 563SB004 | 0.29 | 0.26 | | | |
| | 563SB005 | 0.24 | 0.16 | | | |
| | 563SB006 | 0.13 | ND | | | |
| | 563SB001 | 3280.00 | 1980.00 | NA | NA | NA |
| Calcium (Ca) | 563SB002 | 1690.00 | 9500.00 | | | |
| | 563SB003 | 2780.00 | 1140.00 | | | |
| | 563SB004 | 8950.00 | 2640.00 | | | |
| | 563SB005 | 2380.00 | 1570.00 | | | |
| | 563SB006 | 2000.00 | 2125.00 | | | |
| | 563SB007 | 2175.00 | 2910.00 | | | |
| | 563SB008 | 2680.00 | 2600.00 | | | |
| | 563SB009 | 1360.00 | 1670.00 | | | |
| | 563SB001 | 11.90 | 20.30 | 39.00 | 94.60 | 75.20 |
| Chromium (Cr) | 563SB002 | 16.70 | 11.60 | | | |
| | 563SB003 | 8.80 | 7.30 | | | |
| | 563SB004 | 22.20 | 20.70 | | | |
| | 563SB005 | 17.40 | 17.00 | | | |
| | 563SB006 | 21.40 | 19.10 | | | |
| | 563SB007 | 12.70 | 27.90 | | | |
| | 563SB008 | 6.40 | 15.10 | | | |
| | 563SB009 | 6.30 | 7.20 | | | |
| | 563SB001 | 0.95 | 1.20 | 470.00 | 19.00 | 14.90 |
| Cobalt (Co) | 563SB002 | 1.10 | 1.60 | | | |
| | 563SB003 | 31.80 | 1.10 | | | |
| | 563SB004 | 38.30 | 11.00 | | | |
| | 563SB005 | 2.00 | 2.50 | | | |
| | 563SB006 | 7.20 | 1.50 | | | |
| | 563SB007 | 4.05 | 2.20 | | | |
| | 563SB008 | 14.90 | 1.50 | | | |
| | 563SB009 | 2.20 | 3.10 | | | |
| | 563SB001 | 3.80 | 1.70 | 310.00 | 66.00 | 152.00 |
| Copper (Cu) | 563SB002 | 3.70 | 22.10 | | | |
| | 563SB003 | 20.90 | 3.00 | | | |
| | 563SB004 | 2.50 | 2.60 | | | |
| | 563SB005 | 2.80 | 2.10 | | | |

Chemicals Detected in Zone E Soil Samples
AOC 563

| Name | ID | Surface Conc. | Subsurface Conc. | RBC (THQ=.1) | Surface UTL | Subsurface UTL * |
|----------------|----------|---------------|------------------|--------------|-------------|------------------|
| Iron (Fe) | 563SB006 | 2.30 | 1.10 | | | |
| | 563SB007 | 51.50 | 3.00 | | | |
| | 563SB008 | 4.90 | 3.00 | | | |
| | 563SB009 | 5.60 | 4.70 | | | |
| | 563SB001 | 10600.00 | 20100.00 | 2300.00 | NA | NA |
| | 563SB002 | 11900.00 | 9440.00 | | | |
| | 563SB003 | 9750.00 | 5930.00 | | | |
| | 563SB004 | 23900.00 | 21400.00 | | | |
| | 563SB005 | 17500.00 | 12800.00 | | | |
| | 563SB006 | 21600.00 | 16400.00 | | | |
| Lead (Pb) | 563SB007 | 10850.00 | 31800.00 | | | |
| | 563SB008 | 6500.00 | 16800.00 | | | |
| | 563SB009 | 7190.00 | 6590.00 | | | |
| | 563SB001 | 19.10 | 8.40 | 400.00 | 265.00 | 173.00 |
| | 563SB002 | 11.50 | 58.30 | | | |
| | 563SB003 | 23.60 | 8.10 | | | |
| | 563SB004 | 11.00 | 10.80 | | | |
| | 563SB005 | 10.60 | 8.40 | | | |
| | 563SB006 | 13.40 | 9.50 | | | |
| | 563SB007 | 29.75 | 11.60 | | | |
| Magnesium (Mg) | 563SB008 | 9.40 | 15.60 | | | |
| | 563SB009 | 19.70 | 17.90 | | | |
| | 563SB001 | 453.00 | 992.00 | NA | NA | NA |
| | 563SB002 | 652.00 | 443.00 | | | |
| | 563SB003 | 592.00 | 285.00 | | | |
| | 563SB004 | 1180.00 | 970.00 | | | |
| | 563SB005 | 664.00 | 783.00 | | | |
| | 563SB006 | 951.00 | 871.00 | | | |
| | 563SB007 | 599.00 | 1290.00 | | | |
| | 563SB008 | 286.00 | 556.00 | | | |
| Manganese (Mn) | 563SB009 | 277.00 | 335.00 | | | |
| | 563SB001 | 32.70 | 28.90 | 180.00 | 302.00 | 881.00 |
| | 563SB002 | 19.10 | 65.10 | | | |
| | 563SB003 | 63.60 | 39.70 | | | |
| | 563SB004 | 36.90 | 31.30 | | | |
| | 563SB005 | 39.70 | 57.00 | | | |
| | 563SB006 | 26.10 | 22.45 | | | |
| | 563SB007 | 55.40 | 37.70 | | | |
| | 563SB008 | 79.60 | 34.70 | | | |
| | 563SB009 | 115.00 | 71.70 | | | |
| Mercury (Hg) | 563SB001 | 0.04 | 0.05 | 2.30 | 2.60 | 1.59 |
| | 563SB002 | 0.05 | 0.07 | | | |
| | 563SB003 | 0.05 | ND | | | |
| | 563SB004 | 0.05 | 0.05 | | | |
| | 563SB007 | 0.05 | ND | | | |
| | 563SB008 | ND | 0.05 | | | |
| | 563SB009 | ND | 0.10 | | | |
| Nickel (Ni) | 563SB001 | 2.10 | ND | 160.00 | 77.10 | 57.00 |
| | 563SB002 | 2.50 | 2.50 | | | |
| | 563SB003 | 5.20 | 3.40 | | | |
| | 563SB004 | 4.50 | 2.20 | | | |

**Chemicals Detected in Zone E Soil Samples
AOC 563**

| Name | ID | Surface Conc. | Subsurface Conc. | RBC (THQ=.1) | Surface UTL | Subsurface UTL * |
|---------------|----------|------------------|---------------------|-----------------|----------------|---------------------|
| | 563SB005 | 2.80 | 4.00 | | | |
| | 563SB006 | 3.20 | 3.20 | | | |
| | 563SB007 | 6.00 | 2.40 | | | |
| | 563SB008 | 4.60 | 3.20 | | | |
| | 563SB009 | 2.80 | 2.20 | | | |
| Potassium (K) | 563SB002 | 2070.00 | ND | NA | NA | NA |
| Selenium (Se) | 563SB001 | 0.59 | 0.61 | 39.00 | 1.70 | 2.40 |
| | 563SB003 | 0.60 | ND | | | |
| | 563SB004 | 0.74 | ND | | | |
| | 563SB005 | 0.82 | ND | | | |
| | 563SB006 | ND | 0.61 | | | |
| | 563SB007 | ND | 0.63 | | | |
| | 563SB008 | ND | 0.59 | | | |
| Sodium (Na) | 563SB002 | 125.00 | ND | NA | NA | NA |
| | 563SB003 | 175.00 | ND | | | |
| | 563CB006 | ND | 68.60 | | | |
| | 563SB007 | 147.00 | ND | | | |
| Vanadium (V) | 563SB001 | 16.80 | 35.60 | 55.00 | 94.30 | 155.00 |
| | 563SB002 | 16.00 | 11.80 | | | |
| | 563SB003 | 12.00 | 9.00 | | | |
| | 563SB004 | 29.60 | 28.00 | | | |
| | 563SB005 | 26.60 | 22.90 | | | |
| | 563SB006 | 34.90 | 29.50 | | | |
| | 563SB007 | 18.20 | 36.90 | | | |
| | 563SB008 | 10.40 | 19.10 | | | |
| | 563SB009 | 8.70 | 10.50 | | | |
| Zinc (Zn) | 563SB001 | 14.70 | 12.20 | 2300.00 | 827.00 | 886.00 |
| | 563SB002 | 15.30 | 73.10 | | | |
| | 563SB003 | 18.90 | 10.90 | | | |
| | 563SB004 | 15.30 | 16.40 | | | |
| | 563SB005 | 12.60 | 13.80 | | | |
| | 563SB006 | 19.80 | 12.85 | | | |
| | 563SB007 | 34.15 | 20.90 | | | |
| | 563SB008 | 12.70 | 17.30 | | | |
| | 563SB009 | 24.20 | 22.10 | | | |

Notes:

ND: Not Detected

NS: No Sample Taken/Sample Not Analyzed

NA: Not applicable

For compounds detected in both the primary and duplicate sample, the concentration for both detections are averaged and listed as one detection.

For compounds that were detected in only one of the primary or duplicate sample, the value of the detection was used.

Table 10.31.C
Chemicals Present in Site Samples
AOC 563 - Groundwater
NAVBASE - Charleston
Charleston, SC

| Parameter | | Frequency of Detection | | Range of Detection | | Average Detected Conc. | | Range of SQL | | Screening Concentration Residential RBC Reference | | Units | Number Exceeding Res. Ref. | |
|----------------------------|---|------------------------|---|--------------------|--------|------------------------|-------|--------------|-------|---|------|-------|----------------------------|--|
| Deep Wells | | | | | | | | | | | | | | |
| Inorganics | | | | | | | | | | | | | | |
| Barium (Ba) | | 1 | 1 | 11.1 | 11.1 | 11.1 | NA | NA | 260 | 218 | UG/L | | | |
| Calcium (Ca) | N | 1 | 1 | 53800 | 53800 | 53800 | NA | NA | NA | NA | UG/L | | | |
| Iron (Fe) | N | 1 | 1 | 156 | 156 | 156 | NA | NA | NA | NA | UG/L | | | |
| Magnesium (Mg) | N | 1 | 1 | 11800 | 11800 | 11800 | NA | NA | NA | NA | UG/L | | | |
| Manganese (Mn) | | 1 | 1 | 50.1 | 50.1 | 50.1 | NA | NA | 84 | 869 | UG/L | | | |
| Potassium (K) | N | 1 | 1 | 5940 | 5940 | 5940 | NA | NA | NA | NA | UG/L | | | |
| Sodium (Na) | N | 1 | 1 | 110000 | 110000 | 110000 | NA | NA | NA | NA | UG/L | | | |
| Shallow Wells | | | | | | | | | | | | | | |
| Inorganics | | | | | | | | | | | | | | |
| Aluminum (Al) | * | 2 | 3 | 356 | 22000 | 11178 | 125 | 125 | 3700 | 2810 | UG/L | 1 | 1 | |
| Arsenic (As) | * | 3 | 3 | 5.8 | 34.4 | 22.3 | NA | NA | 0.045 | 18.7 | UG/L | 3 | 2 | |
| Calcium (Ca) | N | 2 | 3 | 37900 | 53800 | 45850 | 22800 | 22800 | NA | NA | UG/L | | | |
| Chromium (Cr) | * | 2 | 3 | 1.4 | 42.9 | 22.15 | 1 | 1 | 18 | 12.3 | UG/L | 1 | 1 | |
| Cobalt (Co) | | 2 | 3 | 5 | 10.9 | 7.95 | 2 | 2 | 220 | 2.5 | UG/L | | 2 | |
| Copper (Cu) | | 2 | 3 | 3.6 | 8.8 | 6.2 | 2 | 2 | 150 | NA | UG/L | | | |
| Iron (Fe) | N | 3 | 3 | 129 | 29000 | 11763 | NA | NA | NA | NA | UG/L | | | |
| Lead (Pb) | * | 1 | 3 | 17.6 | 17.6 | 17.6 | 3 | 3 | 15 | 4.8 | UG/L | 1 | 1 | |
| Magnesium (Mg) | N | 3 | 3 | 3630 | 13200 | 8837 | NA | NA | NA | NA | UG/L | | | |
| Manganese (Mn) | | 3 | 3 | 150 | 334 | 232 | NA | NA | 84 | 2560 | UG/L | 3 | | |
| Nickel (Ni) | | 3 | 3 | 5.1 | 6.8 | 6.13 | NA | NA | 73 | 15.2 | UG/L | | | |
| Vanadium (V) | * | 2 | 3 | 1.4 | 50.1 | 25.75 | 1 | 1 | 26 | 11.4 | UG/L | 1 | 1 | |
| Semivolatile Organics | | | | | | | | | | | | | | |
| Benzoic acid | | 1 | 3 | 1 | 1 | 1 | 50 | 50 | 15000 | NA | UG/L | | | |
| Volatile Organics | | | | | | | | | | | | | | |
| 1,2-Dichloroethene (total) | * | 3 | 3 | 8 | 12 | 10 | NA | NA | 5.5 | NA | UG/L | 3 | | |
| Toluene | | 1 | 3 | 9 | 9 | 9 | 5 | 5 | 75 | NA | UG/L | | | |
| Trichloroethene | * | 1 | 3 | 120 | 120 | 120 | 5 | 5 | 1.6 | NA | UG/L | 1 | | |

* - Identified as a COPC
N - Essential nutrient
UG/L - micrograms per liter
SQL - Sample quantitation limit
NA - Not applicable

A COMPREHENSIVE REVIEW OF COMMON LABORATORY ARTIFACTS DETECTED IN ENVIRONMENTAL SAMPLES FROM THE CHARLESTON NAVAL BASE

This memo serves as a technical review of possible industrial, laboratory and field sampling uses of common laboratory chemicals that have also been detected in varying media and concentrations at the Charleston Naval Base. The purpose of this memo is to show possible paths of introduction of these chemicals into the environmental samples through various pathways. Heartland Environmental Services, Inc. did an independent literature search to supplement this memo. Heartland's text and references are featured as Attachment A. Since much of the blame for common artifacts in environmental samples is usually placed on the laboratory, a brief discussion on the role of the laboratory is needed.

Under the Resource Conservation Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) investigations, environmental samples are routinely collected by field personnel and sent to analytical laboratories for analysis to determine if contaminants of concern are present and at significant concentrations to pose a risk to either human or ecological assessments. Laboratories selected to analyze environmental samples often go through intensive laboratory auditing processes either by the client's representatives or by individual government agencies or its appointee to assess a laboratory's capabilities. After successful completion of the audit and successful analysis of performance evaluation (PE) samples, the laboratory will become certified or given a stamp of approval. The laboratory then performs laboratory analysis of samples using regulated methods promulgated throughout the United States.

The RCRA methods commonly called SW-846 and the CERCLA methods called CLP, give step by step instructions on how a laboratory must follow the laboratory procedures. Built into these methods are quality controls and standards a laboratory must adhere to in order for data to be acceptable. A laboratory must make every effort to meet these quality control requirements or face the possibility of the data not being acceptable or non compliant by a data validator. When the laboratory has shown through data validation that the data is compliant but unexplainable results show up for chemicals like acetone, methylene chloride, and bis(2-Ethylhexyl)phthalate (BEHP), a more thorough review of the data is needed.

It is the objective of the data user to try to understand the usage of these chemicals. The where and why of common contaminants being detected also needs to be explained before a judgement can be made of the data. In that respect historical data plays a very important role in determining the usefulness of the data and understanding how the laboratory operates supplements that role. But normal standard operating procedures of laboratory and field personnel can lead to contamination of samples with acetone, methylene chloride and BEHP.

Acetone and methylene chloride are parameters listed in USEPA SW-846 method 8260 and USEPA CLP volatile organic analysis method. Both chemicals are used throughout the laboratory in extraction and cleanup solvents (VOA methods do not use extraction and cleanup procedures)

for soils and water samples. Acetone, derived from the oxidation of isopropyl alcohol, is used primarily in industry in paints, varnish, and lacquer solvent. A laboratory will use acetone to dissolve semivolatile compounds for stock standard solutions for method SW-846 8270 and in a solvent solution (300ml 1:1) with either methylene chloride or hexane used in sample quantitative extraction methods for soils. The EPA approved extraction methods that a laboratory uses for soils/solids samples are solid phase, soxhlet, pressurized fluid, and ultrasonic. Analytical clean up procedures, used to help eliminate sample interference and false positives and negatives, such as alumina, florisil, silica, acid-base partition, and sulfur also use acetone as an extraction solvent (100 ml). Specifically to the Charleston Naval Base, acetone is used in extractions of solids for methods 8080A, 8081A, 8082 (pesticides and PCBs) 8141A (organophosphorus pesticides), 8150B (herbicides) and 8270C (semivolatiles).

Methylene chloride, derived from the chlorination of methyl chloride, is used primarily in industry in paint removers and solvent degreasing. A laboratory uses methylene chloride to prepare the Gas Chromatography/ Mass Spectrometry (GC/MS) tuning standard for method 8270, as a solvent solution with acetone (300 ml total solvent at 1:1 for each sample) used in sample quantitative extraction methods for soils and as a stand alone solvent (500 ml) for water samples. The EPA approved extraction methods that a laboratory uses for water samples are liquid-liquid, continuous liquid-liquid, and solid phase. Methylene chloride is used in sample analytical clean up procedures such as alumina, florisil, silica gel, gel permeation, and acid-base partition (100 ml) which help to eliminate interferences.

Methylene chloride is used as a precleaning agent for sodium sulfate which is used after every extraction and cleanup procedure as a drying agent to remove moisture from extracts. Methylene chloride is also used as a rinse for the polytetrafluoroethylene (PTFE) boiling chips needed to help concentrate down the volumes of extraction and cleanup solvents produced for every sample to the correct volume. Both the sodium sulfate and the boiling chips are to be dried in an oven for several hours before usage and stored in glass containers and not plastic to prevent cross contamination from BHEP. Specifically to the Charleston Naval Base, methylene chloride is used in extractions of liquids for methods 8080A, 8081A, 8082 (pesticides and PCBs) 8141A (organophosphorus pesticides), 8150B (herbicides), 8270C (semivolatiles), and 8290 (dioxin). Another possible pathway of methylene chloride contamination according to method 8260A is "Laboratory clothing worn by the analyst should be clean, since clothing previously exposed to methylene chloride fumes during liquid/liquid extraction procedures can contribute to sample contamination." As an additional precaution it is extremely important that air ventilation systems do not lead between the extraction labs and volatile analysis labs as acetone and methylene chloride will contaminate samples.

BEHP is derived from the reaction of 2-ethylhexanol and phthalic anhydride and is used in industry as a plasticizer for many resins and elastomers and as a liquid in vacuum pumps. Laboratories do not use BEHP for any extractions or as a cleanup agent but BEHP can come in

contact with environmental samples in other ways. If sample containers have plastic lids instead of screw caps lined with Teflon septas, possible contamination from phthalates (BEHP) can be seen in the samples. As noted in method 8080A of the USEPA SW-846 Test Methods, other phthalate interferences are discussed as follows "Interferences by phthalate esters can pose a major problem in pesticide determinations when using the electron capture detector. These compounds generally appear in the chromatogram as large late-eluting peaks, especially in the 15% and 50% fractions from Florisil clean-up. Common flexible plastics contain varying amounts of phthalates. These phthalates are easily extracted or leached from such materials during laboratory operations. Cross contamination of clean glassware routinely occurs when plastics are handled during extraction steps, especially when solvent-wetted surfaces are handled. Interferences from phthalates can best be minimized by avoiding contact with any plastic materials. Exhaustive cleanup of reagents and glassware may be required to eliminate background phthalate contamination." Method 8061A (Phthalate Esters by Gas Chromatography) goes into further detail discussing Soxhlet extractors and possible cross contamination in using them. "If Soxhlet extractors are baked in the muffle furnace, care must be taken to ensure that they are dry. Thorough rinsing with hot tap water, followed by deionized water and acetone, is not an adequate decontamination procedure. Even after a Soxhlet extractor was refluxed with acetone for three days, with daily solvent changes, the concentration of bis(2-Ethylhexyl)phthalate was as high as 500 ng per washing. Storage of glassware in the laboratory introduces contamination, even if the glassware is wrapped in aluminum foil. Therefore, any glassware used in Method 8061 should be cleaned immediately prior to use". The method goes on to state that "Florisil and alumina may be contaminated with phthalate esters and, therefore, use of these materials in sample cleanup should be employed cautiously. Washing of these materials prior to use with the solvent(s) used for elution during extract cleanup was helpful, however, heating at 320°C for Florisil and 210°C for alumina is recommended. Phthalate esters were detected in Florisil cartridge method blanks at concentrations ranging from 10 to 460 ng, with 5 phthalate esters in the 105 to 460 ng range. Complete removal of the phthalate esters from Florisil cartridges does not seem possible, and it is therefore desirable to keep the steps involved in sample preparation to a minimum." As with acetone and methylene chloride, BEHP may have pathways of contamination inadvertently leading to environmental samples if extreme caution and care are not taken in the laboratory to prevent them. Pathways of possible contamination do not solely belong to the laboratory. Field sampling procedures need to be scrutinized in depth as well to help eliminate cross contamination.

Field sampling procedures may lead to possible contamination of samples. Plastic sheeting and gloves are routinely used to keep both the sampling area and field personnel contaminate free but caution needs to be taken to prevent cross contamination to samples. Sampling tools such as stainless steel trowels, teflon trowels and teflon tubing should remain covered with aluminum foil until the point of sampling so as not to come in contact with the plastic sheeting. When wearing plastic gloves the sampler needs to use extra caution so that none of the sample comes in contact

with the glove as the sample bottle is being filled and possibly causing a cross contamination with phthalates.

It is also necessary to follow proper sampling decontamination procedures to help prevent cross contamination. Though there are no solvents used for decontamination on the Charleston Naval Base that are listed on the VOA method list, isopropyl alcohol is used as a solvent rinse on sampling equipment as described in the CSAP. Extreme caution needs to be taken when using isopropyl alcohol for decontamination. When using isopropyl alcohol as a rinse after Alconox detergent and DI water wash, the alcohol must be thoroughly rinsed with DI water and allowed to completely dry before additional samples are taken. If too much alcohol is used, or too little DI water for a final rinse, samples can show increased levels of acetone when analyzed.

A base wide review of the data showed acetone was randomly showing up in samples throughout the Naval Base. To help narrow down the possible routes of exposure of acetone to the samples, a decontamination experiment was conducted in the Fall of 1996 and blind samples were collected and sent to Southwest Laboratories to be analyzed.

Three blind soil samples and one water sample spiked with isopropyl alcohol were sent to the lab to be analyzed using method 8260. The equipment used to collect the sample was a hand auger. One sample was taken following the decontamination procedures listed in the CSAP and after the auger was let to dry. One soil sample was taken following the new EPA decontamination procedures set forward in their August 1996 audit. The audit stated that a smaller amount of DI water (using a squirt bottle filled with DI water to rinse off the alcohol instead of the larger amounts previously used) was to be used. One sample was also taken using a hand auger that was wrapped in tin foil and stored in the field trailer. As an added bonus, one water vial was spiked with a few drops of isopropyl alcohol. A trip blank was also submitted for analysis in case of any carryover contaminants.

The hand auger that was wrapped in foil had acetone detected at 10 ppb with no TICs reported. Using the August 1996 EPA audit decontamination procedures, acetone was detected at 200 ppb with TICs of isopropyl alcohol at 190 ppb. The concentration of isopropyl alcohol is estimated due to the fact that the laboratory is not required to establish instrument calibration criteria on TICs. Using the CSAP decontamination procedures, acetone was detected at 31 ppb with no tentatively identified compounds (TICs). The water spike showed acetone at 2900 and a TIC of isopropyl alcohol at 180000 ppb. The results of the water spike are estimated due to the sample having to be diluted in order for the instrument to properly quantify the results. The concentration of isopropyl alcohol is estimated due to the fact that the laboratory is not required to establish instrument calibration criteria on TICs.

It is apparent that sampling equipment needs to be rinsed heavily with DI water when required to use isopropyl alcohol as a decontamination step, and let it air dry as long as possible to help eliminate the possibility of cross contamination of unwanted acetone. It is not acceptable to have a bucket of DI water at the end of the decontamination line that is used all day without changing the water frequently. This happens far too many times. Isopropyl alcohol builds up and contributes to the cross contamination of samples with acetone.

For the data reviewer the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review state that acetone, methylene chloride and BEHP are common contaminants and certain rules such as the 10X rule need to be followed when evaluating blanks (lab or field) along with the samples. A caveat to this rule is when equipment and rinsate blanks are taken at the beginning of the day in ideal conditions and not after a full day of sampling, say when isopropyl alcohol has saturated the DI water bucket. This causes the reviewer to scrutinize data between blanks and samples that have not been collected by the same procedures.

As stated earlier, a base wide review of the data was performed on acetone, methylene chloride, and BEHP results to determine if there were trends developing that might shed some light on whether the results were site related or due to cross contamination. The quarterly groundwater monitoring program for all of the individual zones was evaluated in depth due to the concerns posed by the project team. All of the well data collected to date was printed out to see if analytical results showed repeated detections of acetone, methylene chloride, and BEHP. A comparison of soil data (soil borings and Direct Push Technology (DPT) in close proximity to monitoring wells was also made to see if possible leaching to groundwater could have occurred. When reviewing possible soil leaching of contaminants, the soil screening levels (SSL) along with history of the site, need to be considered before a final assessment of the data is made. The SSL for acetone is 8000 ppb ($\mu\text{g}/\text{kg}$), methylene chloride is 10 ppb, and BEHP is 11,000 ppb.

The well ID 638001 from Zone G had acetone results that appeared in two of the groundwater monitoring rounds (3rd and 4th) at concentrations of 3 and 7 ppb. Three wells in Zone H show results that appear in multiple rounds. Well ID 009005 had results of acetone of 11.7 and 19 ppb in the 1st and 3rd respectively. Well ID 009009 had results of acetone of 22 and 4 ppb in the 2nd and 4th rounds and well ID 017005 had acetone results of 17.9 and 360 ppb in the 1st and 3rd rounds.

A review of the soil borings near the above mentioned wells showed that boring ID 638004, taken approximately 75 feet from the well, had a second interval acetone result of 120 ppb. Boring IDs GDHSB056 and GDHSB057 which were located approximately 175 ft. from well 009009 had detections of 27 and 17 ppb respectively. Boring ID 009SB005, taken where a well was constructed, did not have a detection for acetone.

A review of the acetone results for DPT samples in Zone A showed no correlation to the nearest well pair 03915 and 15D and the DPT samples taken in Zone F at AOC 607 did not have acetone detections. Four second round groundwater DPT samples were taken in Zone L because of first round detections of acetone in either soil and/or water DPT samples. Samples 037GP001, 037SP002, 037GP002, and 037GP003 in subzone F had detections of 65.8 ppb, 12.9 ppb, 5.63 ppb, and 7.03 ppb respectively. The second round samples for 037GP001 and 037GP003 did not have detections for acetone and sample 037GP002 had a result of 2 ppb.

Sample 037GP032 in subzone C had a first round detection of 683 ppb for acetone. The second round sample had a result of 15 ppb.

A review of the methylene chloride results showed well ID 009007 showing results of 130, 68, and 330 ppb in the 2nd, 3rd and 4th rounds and well ID 017002 showing methylene chloride showing results of 520 and 240 ppb in the 2nd and 3rd rounds. The review of the soil borings collected around the vicinity of those wells showed no detections of methylene chloride. There was also no correlation between the DPT samples collected in Zones A and F and the wells that are in the vicinity of the DPT samples.

A review of the BEHP data shows that in Zone E well ID GDE009 had detections of 2 and 10 ppb for the 1st and 2nd rounds of data and well ID GDE09D had detections of 1 and 5 ppb for the 1st and 2nd rounds. The review of the soil borings for those wells showed non detects. Well ID 663002 in Zone H had detections of 180 and 59 ppb for the 3rd and 4th rounds and one soil boring, 663SB002 had a detection of 131 ppb of BEHP. Well ID 014003 had detections of 5 and 2 ppb for the 1st and 4th rounds. The site 684 soil borings taken around the well showed no detections for BEHP. Well ID 178001 had detections of 530 and 290 ppb in the 2nd and 3rd rounds. The site 178

borings taken around the well showed no detections for BEHP. Well ID GDH06D had BEHP detections of 3.9 and 230 ppb for the 1st and 2nd rounds. Soil boring GDHSB006 did not have detections of BEHP. Well ID GDH09D had detections of 6.9 and 2 ppb in the 2nd and 3rd rounds. The soil borings GDH076, GDH084 and GDH085 did not have detections of BEHP.

Heartland Environmental's task was to investigate the possible uses of methylene chloride at industrial and Department of Defense facilities and the possibility of acetone being a contaminant in isopropyl alcohol. Of particular interest is the information from Fisher Scientific Company that specifies isopropyl alcohol contains .002 % (20ppm) of acetone. The type of isopropyl alcohol used at NAVBASE Charleston is the type Fisher's analytical reports discusses. Attachment B includes documentation from various USEPA resources as a supplement to this memo.

Findings regarding trace level methylene chloride and acetone contamination

**Prepared for: Charlie Vernoy, EnSafe
February 9, 1998**

Documentation concerning trace level methylene chloride and acetone contamination in a field investigation is very difficult to discover. Based on the review of many technical publications at several universities in St. Louis and extensive inquiries on the internet using five different databases for searches, Heartland ESI has not been able to discover evidence of prior papers concerning trace level contamination in the field. However, based on our extensive research, we have uncovered several documents which would support EnSafe's supposition that the concentrations of methylene chloride and acetone detected are field/laboratory contaminants.

Methylene chloride, CAS 75-09-2, is most widely used by companies that produce paint strippers, which have been determined to be a major contributor of hazardous waste generation in the Department of Defense. In addition, other companies use methylene chloride to clean metal surfaces. Thru the use of the strippers, it is plausible to ascertain that an uncertain amount of methylene chloride could randomly contaminate field samples without bias for quarterly monitoring. Methylene chloride is also categorized as a common laboratory contaminant that may be present in concentrations less than 25 $\mu\text{g/L}$ or $\mu\text{g/Kg}$ without being outside the technical acceptance criteria. Therefore, based on the presence of methylene chloride at the site in question as a component of paint strippers and cleaners and the allowable presence of methylene chloride in "blank" samples, all trace levels of methylene chloride, (< 100 ppb or $< 10\text{X}$ methylene chloride CRQL) should be considered to be a field and/or laboratory contaminant.

The acetone, CAS 97-94-1, detected at the site can be attributed to the isopropanol utilized to decontaminate the sampling equipment. EnSafe used Fisher ACS grade isopropanol, which according to Ms. Deborah Hostetter, Senior Chemical Sales Specialist for Fisher Scientific, contains acetone as a contaminant. Deionized (DI) water rinses after the isopropanol decontamination is critical to insure that the isopropanol has been cleansed from the surface. After a field audit, EnSafe was instructed by the EPA to rinse the equipment with less DI water. If the equipment was not properly decontaminated with enough DI water to completely rid the equipment of isopropanol, traces of acetone would be present in field samples (as noted). Therefor, all trace acetone results (< 100 ppb) can be attributed to the acetone contamination in the isopropanol.



Figure C-1
Shallow Groundwater Contour Map, May 2002
AOC 563
Charleston Naval Complex

